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NEW SERIES
VOL. LXVIII, No. 1764

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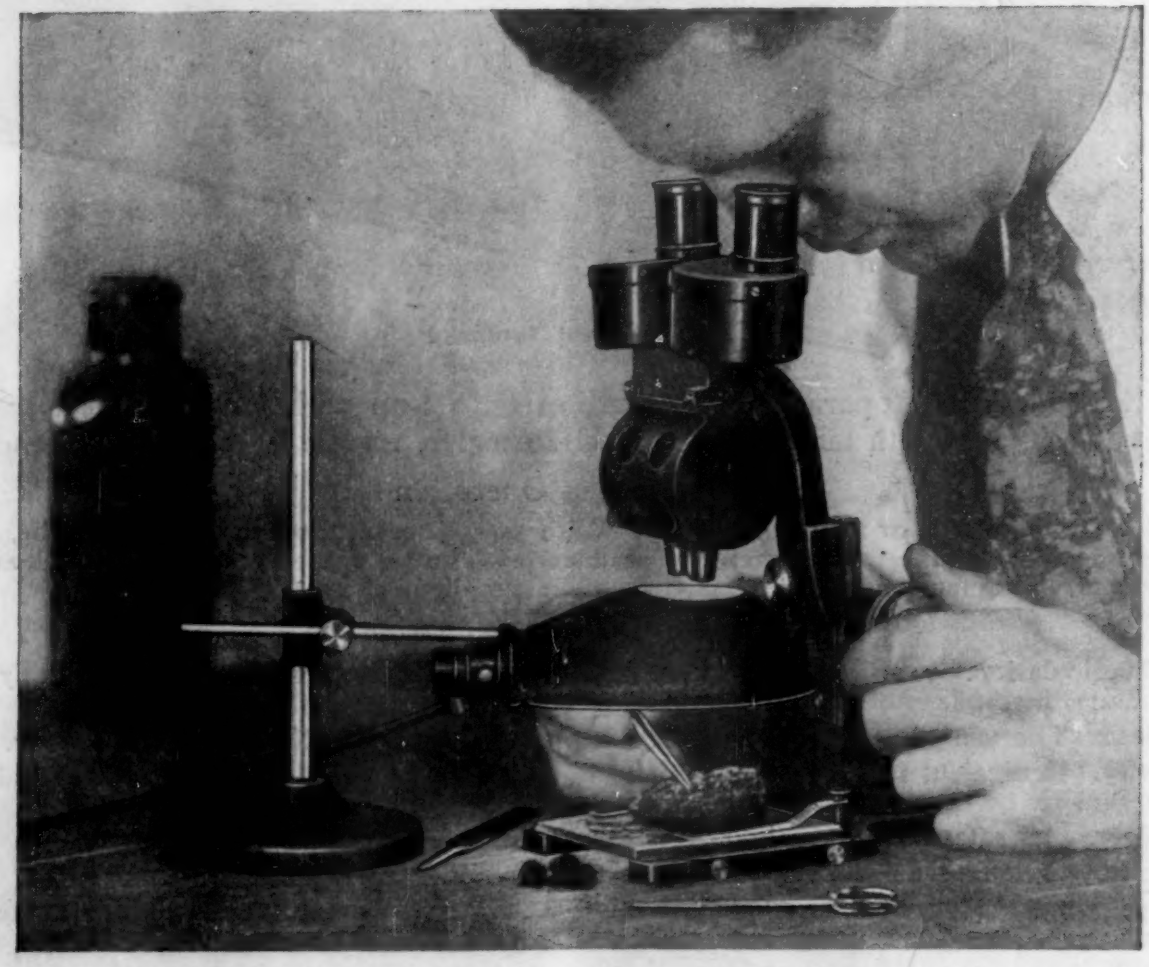

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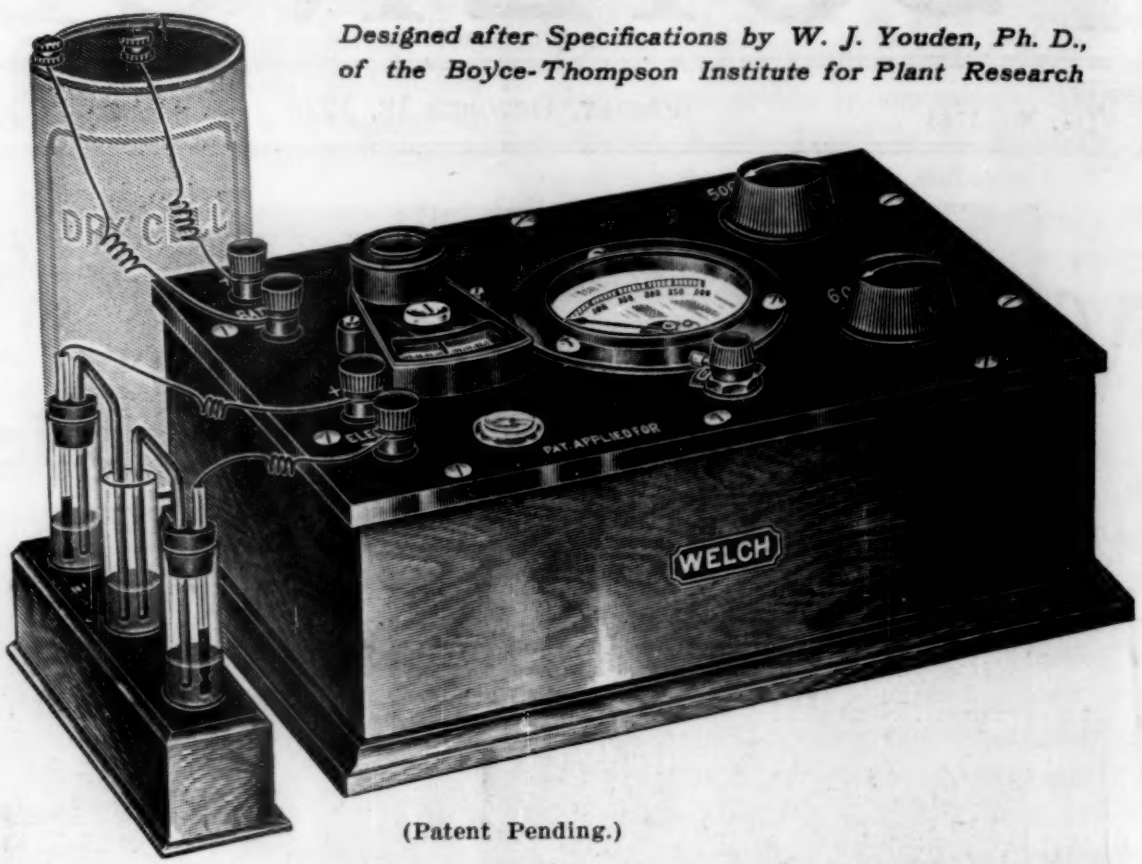

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SCIENCE

VOL. LXVIII OCTOBER 19, 1928 No. 1764

CONTENTS

The Twenty-third International Congress of Americanists: DR. FRANZ BOAS 361

Photosynthesis: PROFESSOR E. C. C. BALY 364

Millionth Scale Map of Hispanic America: DR. ISAIAH BOWMAN and RAYE R. PLATT 367

Calvin Olin Esterly: PROFESSOR WILLIAM E. RITTER 369

Scientific Events:
The International Temperature Scale; The Naval Gravity Determination Survey; Dedication of the Shanklin Laboratory of Biology at Wesleyan University; The New York Medical Center; The Michelson Meeting of the Optical Society of America 370

Scientific Notes and News 373

University and Educational Notes 376

Discussion and Correspondence:
Does Pure Iron have Allotropic Transformations? DR. T. D. YENSEN. *Weather Prediction and Weather Control:* PROFESSOR WILLIAM S. FRANKLIN. *A Further Note on the Difficulties encountered by Land Vertebrates in their Development:* PROFESSOR F. H. PIKE. *The Invention of the Dynamo:* DR. HENRY LEFFMANN, PROFESSOR FREDERICK BEDELL 376

Quotations:
A Monument to Medicine 380

Scientific Apparatus and Laboratory Methods:
Further Studies in Quantitative Virological Methods: H. H. MCKINNEY 380

Special Articles:
Human Body Weight—Correlations between Body Widths and Other Physical Measurements on Young Men: PROFESSOR W. R. MILES. *A Preliminary Report on Studies of Fireblight of Apple:* PAUL W. MILLER. *Schistosome Dermatitis in the United States:* PROFESSOR W. W. CORT 382

Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE TWENTY-THIRD INTERNATIONAL CONGRESS OF AMERICANISTS

THE twenty-third International Congress of Americanists met in New York City during the week of the seventeenth of September, 1928. The meeting was well attended by North American, Central American, South American and European scientists.

By invitation of the American Museum of Natural History, the congress met in the halls of the museum. Wednesday the meeting was held in the Museum of the American Indian, Heye Foundation, on Thursday at Columbia University and on Friday at the Brooklyn Museum.

Professor Franz Boas, of Columbia University, was elected president; Mr. N. C. Nelson, of the American Museum of Natural History, general secretary of the congress, and President Henry Fairfield Osborn, of the American Museum of Natural History, was elected honorary president.

At the opening meeting the president paid a tribute to deceased members, particularly to Dr. Pliny Earle Goddard, secretary of the organizing committee, whose untimely death has cut short a career of great usefulness.

The discussions of the congress related almost entirely to ethnological and archeological questions. The first day was devoted to the question of cultural relations between South America and North America. Dr. Max Uhle, of Ecuador, set forth the theory of an ancient interrelation between early North America and South America and discussed the probable ancient relations between Asia and America. Professor K. Th. Preuss, of Berlin, followed with a more detailed study based on the distribution of the archeological types found at San Agustin. Professor Marshall H. Saville, of the Museum of the American Indian, New York City, also discussed the interrelation between northwestern South America and Central America, while Professor A. L. Kroeber, of the University of California, took up the matter in a broader way and set forth his view of an independent origin of the higher civilization of South America and Central America, both of which he thinks have grown up independently on a similar ancient background. Professor Erland von Nordenskiold, of Göteborg, in discussing this subject pointed out particularly that a number of very specific inventions, like the scales in Peru, have never found their way to Central America

and that, therefore, whatever relation may exist must have been a very early one.

The second day of the session was devoted to the discussion of relations between North America and Asia. Dr. Aleš Hrdlička, of the United States National Museum, spoke of the recent relations between Asia and America around Bering Sea which indicate a constant contact between the inhabitants of the two continents in this area. Professor Waldemar G. Bogoras, of Leningrad, Russia, took up the older relations from an ethnological point of view. He compared particularly the religious practices in Siberia with parallel forms in North America and proved that the Bear Cult, which is widely spread in America, occurs in similar forms in Siberia. On the other hand, he pointed out the peculiar attitude toward shaminism in Siberia, which differs from that found in most parts of America. The Siberian native tries to avoid initiation by the supernatural power, while in many cases the American Indian seeks such power, or at least does not resist it. In this connection he described the important ethnographic work carried on in Leningrad on the small tribes of Siberia, a work that is a continuation westward of the investigations of the Jesup North Pacific Expedition. Mr. Waldemar Jochelson, representing the Geographical Society of Moscow, spoke on the ancient and present Kamchadal and pointed out that their cultural relations to the northwest coast Indians of America are much more intimate than those with the intervening Eskimo.

On the same day the problems presented by the Eskimo and the northwest coast Indians were discussed. Professor William Thalbitzer, of Copenhagen, described Eskimo manners and mentality especially as evinced by their music, songs and ritual customs, while Mr. Kaj Birket-Smith, of Copenhagen, discussed the theories of the origin of the Eskimo based particularly on his observations among the inland Eskimo, west of Hudson Bay. He supported the opinions formerly expressed by Boas and Steensby of an inland origin of the Eskimo in the region between Hudson Bay and the Mackenzie River. The ancient forms of Eskimo culture first described from Southampton Island were fully discussed by T. Mathiasson, of Copenhagen, who described Knud Rasmussen's archeological collections from the western Eskimo. Dr. J. A. Mason, of the University of Pennsylvania, Philadelphia, contributed a description of similar material from Point Barrow. It has now been proved that this ancient culture extended from Alaska to Baffinland. Peculiar forms found in ancient material from Alaska resemble to a certain extent the interesting decorations on Aleut hats which were described by S. V. Ivanoff, of Leningrad.

Mr. C. M. Barbeau, of the National Museum of Canada, tried to prove on the ground of family legends a southward migration of the northwest coast Indian tribes. He also pointed out that the famous totem poles of the northwest coast are a modern development of art which arose towards the middle of the nineteenth century.

The much discussed problem of relations between South America and the islands and continents west of the South Pacific was the subject of a paper by Professor W. Koppers, of Vienna, who based his argument particularly upon the Kulturkreis theory and tried to show that the cultures of Tierra del Fuego and of southeastern Australia have so many fundamental points in common that they must be considered as developments belonging to the same ancient culture. Mr. J. Imbelloni, of Argentina, called attention to the similarity of club forms in South America and Polynesia and to the similarity of words which seemed to him suggestive. Mr. N. I. Shprinzin, of Leningrad, discussed the similarity of the blowgun in America and Indonesia.

Special attention was paid to the problem of the survival of ancient Indian elements in the modern culture of American tribes and also to the assimilation of European elements in apparently primitive cultures. The former subject was treated particularly by Dr. Franz Termer, of Würzburg, who described the snake dance of the Quiché Indians in Guatemala, and by Mr. O. La Farge, of Tulane University, New Orleans, and Mr. S. K. Lothrop, of the Museum of the American Indian, Heye Foundation. They described the survival of the ancient ritual calendar among the modern Maya. The influence of modern European culture upon American tribes was the subject of a paper by Mr. C. M. Barbeau, who traced historically the origin of the floral designs among the Canadian and neighboring tribes to the influence of the French religious orders who trained the Indians in needlework. Dr. Elsie Clews Parsons, of New York, presented the many important Spanish elements which she discovered in the kachina cult of the pueblos. The kachina cult contains many elements of the Catholic ritual and the prolific development of masks is evidently a new feature, in many ways analogous to the European use of masks in folk-ritual. The dances of the Pueblos are in form analogous to the Spanish dances. Mr. Stewart Culin in a paper on Pueblo masks also emphasized their recent origin. Miss Frances Toor, of Mexico, showed textiles of the Otomí Indians which are based upon Spanish patterns.

The last day of the session was devoted to the discussion of the antiquity of man in America. While Professor Capitan, who was not present, defended the typological study of remains, the principal discussion

was based on the finds in Folsom, which were fully described by Dr. Barnum Brown, of the American Museum of Natural History. Professor Albrecht Penck, of Berlin, who examined the Folsom site, expressed the view that the deposits in which the remains were found are ancient, but postpleistocene. He also discussed the possibility of migration from Asia to America in late pleistocene times. A number of new finds which indicate that man and the mastodon were contemporaneous in South America were briefly referred to.

There was also a discussion on the problem of linguistic relations of American Indian languages. This subject was presented by Professor Edward Sapir, of the University of Chicago, who insisted on the necessity of a rigid application of the principles of Indo-European linguistic science to American problems and defended the grouping together in larger groups of many languages which are considered so far as distinct linguistic stocks. This view was opposed by Professor Franz Boas, of Columbia University, who held that the differentiation is so great and conditions of linguistic contact are so different from those of more recent times in Europe and Asia that the problem of mutual influence of linguistic stocks can not be ruled out.

Besides these general subjects, a considerable number of interesting papers were presented. Dr. Melville J. Herskovits, of Northwestern University, spoke of the culture of the modern Bush Negroes in Surinam, who present a peculiar, well-integrated mixture of African, European and Indian elements. Many of their customs are almost identical with those of the west Sudanese tribes.

Mexican archeology received particular attention. Unfortunately, owing to serious accidents, the Mexican delegation did not arrive until the last day of the congress and their contributions were presented in a special meeting. Mr. J. Reygadas Vertiz reported on the excavations in the pyramid of Tenayuca and Mr. A. Caso reported on the hieroglyphics found in Tenayuca. Mr. I. Marquina presented his elaborate study of the architecture of ancient Mexico and Mr. J. Palacios spoke on his archeological investigations in the state of Chiapas. Mr. G. C. Vaillant, of the American Museum of Natural History, discussed the early so-called archaic cultures of middle America which antedate the more highly developed Maya and Toltec. Other papers read were by A. Toro, of Mexico, on the sacred plants of the Aztecs and their influence upon the pre-Spanish art. Dr. H. Beyer, of Tulane University, spoke of a deity common to the Teotihuacan and Totonacan culture. Mr. E. Noguera discussed the characteristics of Mexican ceramics, Mrs. Zelia Nuttall spoke about Mexican picture writing and Professor A. M. Tozzer, of Harvard University, discussed the Maya and Toltec figures occurring at Chichen Itza.

Most interesting were the illustrated lectures given by Dr. Sylvanus G. Morley, of the Carnegie Institution of Washington, on the important excavations and restorations made in Yucatan, and that by Dr. Frans Blom, of Tulane University, in which he reported on his recent explorations.

In another section of the congress the ethnological problems of South America were discussed. Professor E. von Nordenskiold, of Göteborg, gave an account of the remarkable picture writing of the Cuna Indians. The mythology of South America was discussed by P. M. Gusinde, of Vienna, who pointed out the differences in the concepts of the twin heroes prevailing in the extreme south and in other parts of the continent. Other papers were read by Mr. W. McGovern, of Evanston, on the cultural areas in South America and Dr. Max Uhle on the Sun temple of Cuzco. Mr. A. Simoens da Silva, of Rio de Janeiro, described interesting specimens from Brazil and Mr. I. B. Strelnikov, of Leningrad, reported on the expedition of G. I. Langsdorff, 1821–1829, based on manuscripts which up to this time had been unknown, and which are being prepared for publication. He also reported on some of the results of his own expedition in 1913–1914.

The North American field was treated in a number of papers, among which may be mentioned the report by Dr. Frans M. Olbrechts, of Belgium, on Cherokee divination. The ethnological conditions among the Algonquian tribes of the east were discussed by Dr. A. I. Hallowell, of the University of Pennsylvania; Dr. Truman Michelson, of the Smithsonian Institution, and Father J. M. Cooper, of the Catholic University. Mr. Alexander Lesser discussed the principles of kinship classification among various Siouan tribes. Mr. George Herzog spoke on the distribution of musical styles in North America. A number of papers were devoted particularly to the ethnology and archeology of the southwest. Dr. A. V. Kidder, of the Carnegie Institution, gave a survey of southwestern archeology covering the period beginning 1900. Dr. Ruth F. Benedict and Dr. Ruth L. Bunzel described the psychological background of the cultures of the Pima and of the Pueblos. Dr. Gladys A. Reichard discussed the methods of studying art styles. Professor C. Tagliavini, of Bologna, reported on the Indians of South California, based on early manuscripts which he discovered in Italian libraries.

On Thursday afternoon the congress was entertained by the honorary president, Professor Henry Fairfield Osborn, at his residence in Garrison-on-Hudson. The journey was made on a private steamer furnished by

the American Museum of Natural History. On Friday the congress enjoyed the hospitality of Mr. Frederick B. Pratt, at Glenn Cove.

At the closing meeting it was voted to hold the next session of the congress in 1930 in Hamburg. Professor G. Thilenius, Professor W. Küchler and Dr. A. Warburg were appointed the organizing committee.

FRANZ BOAS

COLUMBIA UNIVERSITY

PHOTOSYNTHESIS[1]

THERE is no process within the confines of chemistry which is of greater interest and importance than that by means of which the living plant prepares the food on which its life and growth depend. This food consists of starch and sugars, together grouped under the general name of carbohydrates, and of certain nitrogen-containing compounds known as proteins. The material from which the plant starts is carbonic acid, or a solution of carbon dioxide, which it obtains from the air, in water which it obtains through its roots from the soil. From this substance alone the plant is able to prepare its supply of carbohydrates, and it is true to say that this chemical process is the fundamental basis of the whole of terrestrial life. This may truly be asserted because the production of the proteins is very closely associated with it and the initial stage is common to the two.

The formation of carbohydrates from carbonic acid when expressed by a chemical equation looks simple enough. There is no doubt that the first product of the process that can be recognized in the plant is a simple sugar, and thus the equation can be written

$$6H_2CO_3 = C_6H_{12}O_6 + 6O_2$$

where the simple carbohydrate is either glucose or fructose. These simple sugars undergo condensation immediately they are formed to give cane sugar or one of the starches, and these changes can readily be written as simple chemical equations.

The mechanism by means of which the plant achieves the synthesis of these complex compounds from carbonic acid has long been a mystery to chemists and to botanists. It is known that the agency used by the plant to effect its purpose is sunlight, and thus the term photosynthesis has been applied to the operation. It is also known that the plant makes use of certain pigments, such as chlorophyll, and it is to these that the color of the leaves is due. The mystery of it all lay in the fact that no one knew what actually takes place, and, indeed, the more chemists and botanists explored, the more puzzling did the problem seem to be.

Perhaps the most puzzling fact of all is that the plant only makes use of sunlight, when all our previous knowledge of light reactions leads us to believe that such light is quite incapable of inducing photosynthesis. This may readily be understood if the amount of energy involved in the synthesis is considered. It has been proved experimentally that in order to synthesize one gram molecule (180 grams) of glucose or fructose there must be supplied to the carbonic acid a minimum quantity of energy equal to 673,800 calories. Whilst it is known that the plant manages in some way to absorb the necessary energy in the form of light, the physicist tells us that it can not directly absorb enough energy from sunlight. Thus the photosynthesis can be brought about by red light of the wave-length 660 $\mu\mu$ when the energy directly absorbed can only be 260,000 calories, which is far below the minimum quantity required.

The experience gained from the ordinary reactions of photochemistry leads to the belief that if it is required to convert carbonic acid into sugars by means of light alone, it will be necessary to use ultra-violet light which is absorbed by carbonic acid, that is to say, light of wave-length 210 $\mu\mu$. It is obvious from this that some unknown factor is operating in vital photosynthesis.

In any endeavor to elucidate the mystery, it is evident that the first line of inquiry must be to study the action of the short wave ultra-violet light upon carbonic acid. This was first investigated by Moore and Webster in 1913, who found no evidence of any reaction taking place. They found, however, that in the presence of certain catalysts, such as colloidal iron hydroxide, small quantities of formaldehyde were produced. Since these results appeared to be at variance with general experience in photochemical investigations, they were again examined some years later in Liverpool, and it was then found that when a stream of carbon dioxide was passed through water irradiated by the light from a quartz mercury lamp, small quantities of formaldehyde were produced. This result seemed to be very satisfactory, since the formaldehyde could be looked upon as an intermediate stage on the way to carbohydrates, especially in view of the fact that Moore and Webster had proved that formaldehyde was converted by light into a substance with properties similar to the simple sugars.

Our observations were criticized by Porter and Ramsperger, who stated that if rigid precautions were taken to guard against the presence of every trace of impurity, no formaldehyde was produced. The suggestion was implied by them that the origin of the formaldehyde was to be found in some unknown im-

[1] Address given before the Royal Institution of Great Britain, on February 3, 1928.

purity. There is, however, an alternative possibility, and one which is more in keeping with the known facts of the natural photosynthesis in the living leaf. There is no doubt that in this reaction the carbonic acid is converted directly into carbohydrates and that formaldehyde as such is not produced, and it seemed that the most probable explanation of the discrepancy between our results and those of Porter and Ramsperger was that the action of the ultra-violet light is to establish a photochemical equilibrium,

$$6H_2CO_3 \leftrightarrows C_6H_{12}O_6 + 6O_2,$$

which reverts to carbonic acid again in the dark. In the presence of oxidizable impurities a small amount of carbohydrates will be formed, which will be photochemically decomposed to formaldehyde. This decomposition of all the carbohydrates by means of ultra-violet light is well known.

There is no need to give here the details of the experiments which were carried out to test this view, and it is sufficient to say that conclusive proof was obtained of the reality of the equilibrium: that is to say, carbohydrates were found to be present in the solution during irradiation by ultra-violet light, and these vanished very quickly after the irradiation was stopped.

This gave us at once a starting point, because it seems evident that if a harmless inorganic reducing agent were added to the solution, carbohydrates should be formed in quantity on exposure to the ultra-violet light. Such a reducing agent is ferrous bicarbonate, and great hopes were raised when it was found that a saturated solution of this compound, which was completely colorless when prepared, gave a copious precipitate of ferric oxide on exposure to ultra-violet light. It was evident that the oxidation took place by reason of the oxygen in the carbohydrate equilibrium in accordance with the equation

$$4Fe(HCO_3)_2 + O_2 = 2Fe_2O_3 + 4H_2O + 8CO_2$$

and indeed it was found that on evaporation of the exposed solution a simple sugar was obtained. The quantity produced was very disappointing and far less than was anticipated, and the conclusion was forced upon us that some unknown factor was taking part in the process.

During many unsuccessful endeavors to improve the yield of the carbohydrates, it was noticed that the ferric oxide was not produced in the body of the solution, but only on the walls of the quartz containing vessels and on the surface of the iron rods used to make the bicarbonate. This led us to suspect that the surface was a determining factor, and we at once changed the experimental method so as to increase the surface as much as possible. In order to secure this a suspension of pure aluminium powder in water, maintained by a stream of carbon dioxide, was exposed to ultra-violet light. Increased yields of carbohydrates were at once obtained, but it was also found that the best yields were obtained when the aluminium powder had been allowed to coat itself with hydroxide by remaining in contact with the water before the exposure to light. This latter observation very materially changed our ideas, since it established the fact that the surface phenomenon is of far greater importance than the reducing action, and indeed raised the question as to whether the latter plays any rôle at all in the process.

In order finally to decide this question an aqueous suspension of pure and freshly prepared aluminium hydroxide, maintained by a stream of carbon dioxide, was exposed to ultra-violet light. There was obtained after filtration and evaporation of the solution a quantity of carbohydrates equal in weight to that produced when aluminium powder was used. This conclusively proved the fundamental significance of the rôle played by the surface, and at the same time the reducing action was found to be entirely unnecessary. Identical results were obtained with other powders, such as aluminium, zinc and magnesium carbonates.

During the course of these experiments it occurred to one of my students (Dr. W. E. Stephen) that if a green powder were used in place of the white ones the photosynthesis might take place in visible light, the green color being suggested by the green color of the plant-pigment chlorophyll. This was found actually to be the case, since a suspension of nickel carbonate maintained by a stream of carbon dioxide in water, on exposure to the light from an ordinary tungsten filament lamp, gave a larger yield of carbohydrates than any of the white powders in ultra-violet light. We soon found that there was no especial virtue in the green color, and that equally good results were given by pink cobalt carbonate.

Apart from the interest which accrues from the fact that the photosynthesis is thus achieved in a way which shows a real analogy with the natural phenomenon, the method with a colored surface and visible light has a very material advantage in that the danger of photochemical decomposition by ultra-violet light is completely eliminated, with the result that the products are obtained in a purer state.

From the above description of the direct photosynthesis of carbohydrates from carbonic acid in the laboratory several points arise which require discussion and explanation. In the first place it may be stated that the most rigid control experiments which we could devise have definitely established the fact

that the carbohydrates are not due to the presence of impurities.

One of the greatest difficulties met with in this work was the preparation of the various materials used for the surfaces, since it is absolutely essential that these be completely free from any trace of alkali. It is well known that when metallic hydroxides and carbonates are precipitated they tend to absorb the alkali, and the removal of this is extraordinarily troublesome. The absence of any alkaline reaction in the filtrate after the powder has been boiled with water is no criterion of purity, and the only satisfactory method is to pass carbon dioxide into a suspension of the powder in water for two hours in the dark, and the filtrate after concentration must yield no weighable quantity of alkaline carbonate.

It was frequently found that the carbonates of nickel and cobalt, even when completely freed from alkali, were entirely ineffective in promoting photosynthesis. These can, however, be activated either by heating to 120° or by exposure in thin layers to ultraviolet light, and this fact afforded a very convincing method of carrying out controls. A quantity of one of these inactive powders gives no trace of carbohydrates when exposed to visible light in the manner described. The same sample of powder when activated and used in the same apparatus, with the same water, the same light, and carbon dioxide from the same source, gives a good yield of carbohydrates. So, once and for all, is all doubt removed as to the possible effect of impurities.

For the benefit of those who may wish to repeat these experiments, it may be stated that more recently it has been found possible to prepare nickel carbonate by a new method which is free from the objections characteristic of its precipitation by means of alkali carbonate. A solution of carbonic acid in conductivity water is electrolyzed, the electrodes being made of nickel plates. The current is taken from a 220 volt circuit, and sufficient resistance is intercalated to reduce the current density to from one or two amperes per square decimeter. The electrolyte is cooled by glass coils through which a stream of water is maintained. With electrodes 190 square centimeters in area it is possible to prepare thirty grams of pure carbonate in twenty-four hours. The carbonate should be collected every day by filtration, and it is advisable to clean the electrodes with emery paper every third day.

To sum up the results, so far as they have been described, it has been found possible in the laboratory to produce carbohydrates directly from carbonic acid by a process which is physically similar to that of the living plant. The essential difficulty in our understanding of the natural photosynthesis has been solved, namely, the use of visible light as the agent in a process which the elementary laws of photochemistry taught us to believe could only be achieved by means of ultra-violet light. As so often happens the explanation when found is very simple. The great amount of energy required to convert the carbonic acid into carbohydrates is supplied to it in two portions, one by the surface and the other by the visible light.

Nothing has as yet been said of the actual carbohydrates which have been photosynthesized in the laboratory. Although as yet our information is still meager, there is no doubt that the photosynthetic syrup is a mixture containing glucose or fructose, or both. There are also present more complex carbohydrates, which can be resolved to the simple sugars by the action of dilute acid. The analogy with the products of natural photosynthesis is too close to be passed by without comment.

Although it has not as yet been possible to carry out a complete analysis of this syrup, owing to the difficulty of preparing a sufficiently large amount, interesting information has been gained from the investigation of the sugar syrup obtained by the action of light upon formaldehyde solution. This has been pursued during the last three years. We owe a debt of gratitude to Sir James Irvine for the signal help he has given us in this work. He himself was the first, in association with Dr. Francis, to prove that glucose is one of the substances actually produced. By oxidation of the sugars to the acids by means of bromine, and the crystallization of the salts of these with brucine, cinchonine and quinine, we have obtained d-gluconic and also d-erythronic acids. This not only confirms Irvine and Francis in their proof of glucose, but it also proves that fructose is formed just as in the living plant. In addition to that, there is produced a mixture of complex acids which afford convincing evidence of the synthesis of complex carbohydrates.

Although it may be thought that the use of formaldehyde as the starting-point takes away something from the interest, yet it must be remembered that it makes but little difference whether in actual fact we start from carbonic acid or formaldehyde. Without doubt the first substance, transiently formed in either case, is the same, namely, activated formaldehyde which polymerizes to the sugars.

The similarity between the vital and the laboratory processes is not confined to the fact that the products from the two are the same. Botanists tell us that in the living plant the photosynthesis takes place on a surface, so also is a surface necessary in the laboratory. It has been found possible to compare the quantities of carbohydrates synthesized for equal areas

exposed to light in the case of living leaves and the glass vessels of the laboratory. These quantities are about the same. Some plants produce more and others produce less than we are able to synthesize. This similarity may be emphasized, because surely Dame Nature in the living leaf has produced the best machine she could for her purpose of food production for her children of the vegetable kingdom.

There is yet another striking feature which is common to the two, photosynthesis *in vivo* and *in vitro*. The light must not be too strong in either, for if it is too strong then harmful results at once supervene. This is due to the poisoning of the surface by the oxygen which is set free. In both cases this poisoning slowly rights itself, and in both the synthesis must not proceed at a greater rate than that of the recovery of the surface from its poisoning.

In fine, so far as we have been able to carry the investigations, the processes in the living plant and in the laboratory show most striking resemblance, not only in the compounds which are formed, but in every feature which is characteristic of either of them.

For my own part I would go further than this, because I believe that these experimental results help us to gain some understanding of the chemistry of life, the chemistry which is so different from that of man's achievements with his test-tube, flask and beaker. Within the confines of vital chemistry reactions take place which are so far outside our own experimental experience that it came to be believed by many that they were under the control of a mysterious force, to which the name of *vis vitalis* was given. One of these processes has come within our purview to-night, the condensation of the simple sugars, glucose and fructose, to form cane sugar, starch and inulin. No one has yet succeeded in effecting these syntheses in his laboratory, but it would seem that something of that nature takes place in our photosynthesis. Why, then, is it that even this step forward has been gained?

The one lesson that we have gained from photosynthesis is that the definitive factor is the very large amount of energy which must be supplied to the carbonic acid before the synthesis of the simple sugars takes place. The means of supplying that energy do not concern the argument. The synthesis proceeds at an energy level which is far higher than is the case in the reactions of ordinary chemistry, and the sugars are formed at that high energy level. I myself believe that the condensation reactions to give the more complex carbohydrates are those which are characteristic of the simple sugars when they exist at the high energy level. The reason why no one has succeeded up till now in inducing these reactions to take place is because no one has hitherto been able to supply the large energy increment necessary.

I myself believe that we find in this the key which unlocks the door of vital chemistry, and that the chemistry of all life is one of high energy, our laboratory experience being confined to the chemistry of low energy. From this viewpoint I see a wondrous vista unfold itself, wherein new understanding, new hopes and new possibilities reveal themselves. Health and vitality must essentially depend on the high energy level being maintained; any lowering of that level will lead to poor health and weak vitality. Knowledge comes to us of the means whereby the high level may be kept unimpaired. The most important sources from which we can absorb high energy are fresh food and ultra-violet light. From the one we learn the necessity of the rapid distribution of our food supply before its high energy is lost, from the other we gain a real understanding of the benefits of ultra-violet light therapy, and, more important still, of the dangers of its misuse. We gain an insight into the chemistry of vitamins, which in the light of our new knowledge reveal themselves as stores of high energy, bottled sunshine so to speak, which yield their energy to restore and maintain the vitality of decadent tissues. A vision thus comes to us of a new chemistry with limits far flung beyond those which constrain our knowledge of to-day, a chemistry which will embrace and coordinate not only the properties of inanimate matter upon this earth, not only the wondrous mechanism of the life of man in health and in disease, but in addition the stupendous marvels of the birth and growth of the worlds outside our own. From those who would decry this as a mere speculation I beg forgiveness, and plead that speculation based on sure experimental fact is the life blood of true scientific research.

E. C. C. BALY

UNIVERSITY OF LIVERPOOL

MILLIONTH SCALE MAP OF HISPANIC AMERICA[1]

THE department of Hispanic-American research of the American Geographical Society has been engaged for the past seven years in the preparation of a new map of Hispanic America and the West Indies. An exhaustive search has been made for original surveys and other source material, and a completely new map is being compiled. The map follows the scheme of the International Map of the World on a scale of 1:1,000,000 and will consist of one hundred sheets,

[1] Résumé of a paper read at a recent meeting of the Federal Board of Surveys and Maps.

each four degrees of latitude by six of longitude. The work is now about half completed. Twenty sheets have been published, ten more are in the engravers' hands and a large number are in various stages of compilation and fair drawing.

The preparation of this map is a part of the program of geographical studies in Hispanic America which the American Geographical Society inaugurated in 1920. The purpose of the map is to provide as accurate a cartographic base as present knowledge will permit for use in the field, for study and for the plotting of distributions.

For many years to come maps of Hispanic America which cover any considerable extent of territory must be compiled maps, because, although many of the Hispanic-American countries are engaged on programs of systematic topographic surveys, progress on such programs is necessarily slow. However, a great deal of survey work of various types and various degrees of merit has been done in recent years in all the Hispanic-American countries. There are of course areas in which no surveys of any sort have yet been made. However, a sufficient number of surveys have been made to afford an excellent cartographic picture of the whole of Hispanic America, once they are assembled and incorporated in a critical compilation.

Much of this material has been published in scientific periodicals, books and sheet maps. It is, therefore, in a sense available for compilation, but it is scattered in many collections and there is no general catalogue of it, nor is there for the individual collections any analysis of the relative merits of their parts. To make thorough use of this source material is, therefore, beyond the scope of the individual compiler or the map concern that must sell its products at a profit. An even more important source of compilation material is the unpublished surveys in the archives of the Hispanic-American governments themselves and in the map departments of foreign and domestic development companies. Because of the confidential nature of these surveys they may well be said to be practically inaccessible to the commercial cartographer.

To compile a map of Hispanic America which will truly represent present cartographic knowledge of the whole region necessitates the assembling and critical study of all possible survey material. Even the best general maps of the Hispanic-American countries fall far short of such accuracy. They are in general practically valueless as a base for field work or for the detailed plotting of distributions. The explorer is handicapped by the fact that he has no maps upon which he can rely to indicate to him the extent and quality of his predecessors' work. The student who undertakes the study of any phase of Hispanic-American geography is balked by the lack of maps upon which to base his studies. He ought not to be obliged to preface his studies with a prolonged examination of cartographic sources and with map compilations for which he may have neither the time nor the technical training. He ought to be provided with maps on a scale sufficiently large for his needs, in which he is assured that the best surveys available have been critically compiled and on which he can readily distinguish between surveyed and unsurveyed areas.

It is in an attempt to supply this need that the American Geographical Society has undertaken to compile a new map of Hispanic America. The society has had most gratifying success in collecting source material. Libraries, scientific institutions, the various bureaus of the federal governments and individual explorers have given much assistance. The Hispanic-American governments have shown great interest in the map and have in many cases placed the entire contents of collections of official surveys at the society's disposal. Development companies have recognized the value to themselves of the type of map which the society is producing and have freely granted the use of their surveys once they have been assured of the integrity of the compilers in handling confidential material. As a result it is believed that for the sheets of the map so far completed use has been made of all the important surveys that have been made in the areas covered by the sheets. In all requests for compilation material the extent of territory to be covered by the map and the scope of the studies to be based on it have been the society's best allies because they are evidence of the disinterested character of the work. The magnitude of these hitherto untapped sources of material for the map of Hispanic America is indicated by the fact that the unpublished surveys received by the society during 1925 and 1926 included 110,000 square miles of high-grade topographic surveys, 60,000 square miles of less accurate topographic surveys and 15,000 miles of traverses.

The standards of the International Map were adopted because they achieve the purposes which the map is designed to serve. Briefly, those purposes are: to use the source material available to all cartographers with greater accuracy and discrimination than has been employed on previously compiled maps; to add to these sources the great mass of material in the archives of government bureaus and the collections of development and construction companies which is not available to the commercial cartographer; to give, by means of contours and layer tints, topographic expression to our best knowledge of the physiography of both the land areas and the

sea floor; to present the cartographic details obtained from the sources used so as to distinguish between surveyed and unsurveyed areas; to express the most accurate information available as to location and status of political boundaries, position and population of towns, location and gauge of railways, location and character of roads, location of telegraph lines and stations; in a word, to furnish a map which will represent, as far as the conventions of the topographic-political map will permit, the results of a critical and exhaustive research into the cartography and human geography of the whole Hispanic-American realm.

To the scheme of the International Map have been added certain modifications considered essential to the thoroughly scientific presentation of the cartographic status of those parts of the world which are not covered by one type of survey. These modifications are a further development of that feature of the International Map which distinguishes between surveyed and unsurveyed rivers and contours by solid and broken lines. They consist of a relative reliability diagram, incorporated in the legend, which classifies by appropriate symbols the types of surveys used in the compilation, and a pamphlet accompanying each sheet which lists the sources used in the compilation of the sheet and discusses the manner in which they are organized with respect to each other. Thus each sheet sets forth both our cartographic knowledge and our cartographic ignorance. In addition, by means of the relative reliability diagram and pamphlet, it indicates to the consultant the character of the survey work which has been done in the area in which he is interested.

These maps will cover sections of Hispanic America that are of the greatest interest to the physiographer and the geologist, by virtue of their physiographical and geological make-up, of scarcely less interest to the meteorologist, the biologist and the student of political and economic geography.

Parallel with the work upon the cartography of Hispanic America we have compiled a catalogue of the maps of Hispanic America in scientific periodicals, sheet map collections, atlases and books contained in the libraries of the American Geographical Society, the New York Public Library, the Library of Congress, the Pan-American Union Library and the libraries of Columbia, Yale and Harvard Universities. Grouped and classified and accompanied by reliability maps and introductory articles on the general subject of Hispanic-American cartography, this catalogue will be published in six volumes.

ISAIAH BOWMAN
RAYE R. PLATT
AMERICAN GEOGRAPHICAL SOCIETY

CALVIN OLIN ESTERLY

THE subject of this article was born on August 1, 1879, at Fort Stockton, Texas, and died at La Jolla, California, on August 10, 1928. He received the degree of bachelor of arts from the University of California, in 1902, and that of doctor of philosophy from Harvard University, in 1907.

Soon after completing his formal education he became professor of zoology in Occidental College, Los Angeles, California. This position he held until his death, though the disease that proved fatal incapacitated him for college work during most of the last years of his life.

In 1910 Dr. Esterly joined the staff of the Scripps Institution of Oceanography at La Jolla, as a non-resident investigator in marine zoology. This position he likewise held to the end of his life, spending most of his vacations and leaves of absence from college duties at the institution. His college work was usually so adjusted as to enable him to devote some time to investigation during the college terms.

Thus "the short and simple annals of" a truly noble life of one type; for greater devotion to a worthy career worthily conceived is rare indeed.

The single sharply defined field of research to which Esterly set himself, and pursued for more than two decades without a moment of doubt about its worth, of swerving in purpose relative to it, or relaxation in pursuing it, brought results the significance of which reaches far beyond the narrow bounds of the specialized field of knowledge involved.

The group of crustaceans, the copepods, which furnished the subject for his doctor's thesis, furnished the main subject for his whole life of research.

These animals constitute the greatly dominant group of minute animal life of the open seas. Numerically they are to the ocean what flies and gnats are to the air. Economically they are even more than that, for they figure much more as food for their pelagic neighbors than do their aerial congeners for their neighbors. The almost illimitable numbers of the smaller pelagic fishes, as the anchovies, sardines and herring, to say nothing about various other groups, depend mainly on the copepods for food.

Any scientist who in the future gives attention to the copepod fauna of the northeastern Pacific will find that no one before Esterly had learned anything worth mentioning about these creatures in this region. But he will find that Esterly described so many dozens of species and did it so well that not much remains for anybody else to do on this aspect of the subject.

But extensive and excellent as were his labors on the taxonomy of the group, these labors were only

door-opening to other more important labors. Whoever, looking out over the Pacific, off the California coast, be the person professional scientist or layman, would like to picture in his imagination what a myriad animal population extending through cubic miles of the ocean water may be doing, as day and night follow each other, month after month and year after year, such doing consisting of the ceaseless activity of the animals in their "struggles for existence," has only to search Dr. Esterly's writings for material out of which to construct such a picture. What the creatures eat, how they catch their prey and how fast they digest it; by what creatures they in turn are preyed upon; when and how they propagate; how the different kinds respond, each largely in its own way, to the change of light from midday to midnight, back and forth, and from midsummer to midwinter, also back and forth; how far into the depths they descend—such are the items of information available for his picture, thanks to Esterly's perseverance and skill in catching, counting, computing statistics and experimenting. The history of marine biology does not furnish many instances of such a well-balanced combination of field, statistical work and laboratory experimentation as is furnished by the researches of Esterly on the Copepoda of the "San Diego area" of the Pacific.

But no account of the man's life, however brief, would do him justice that said nothing about him as a teacher. President Remsen du B. Bird, of Occidental College, with whom he worked hand-in-hand for many years, is especially fitted to speak of him in this capacity:

> Dr. Esterly was one of our great teachers. He had those qualities of personality which endeared him to everybody. He gave himself without stint to the college and his devotion carried him to all its activities. Particularly was he active as chairman of the Committee on Athletics, a position which he handled with tact and fairness and deep interest in student affairs.
>
> There was universal respect for him in the work of the classroom. His quietness, thoroughness and deep interest in all his students won from his colleagues and those who were in his classes the very highest praise. I do not see how a professor in a college such as Occidental could have been better fitted for his task in scholarship, progressive interest in his departmental affairs, wise counselling and fine loyalty than Dr Esterly.

Through the years of my association with Dr. Esterly at the Scripps Institution, I was impressed with his case as an example of the possibilities there are in the identification of teachers of science in non-research colleges and schools, with institutions devoted exclusively to research.

The loss which Dr. Esterly's personal friends and professional associates have suffered from his untimely death is unrecordable in printer's ink. Much less is so recordable the loss suffered by Ruth Orgren Esterly, the wife and vital companion of most of his adult life.

WM. E. RITTER

UNIVERSITY OF CALIFORNIA

SCIENTIFIC EVENTS

THE INTERNATIONAL TEMPERATURE SCALE

THE Seventh General Conference on Weights and Measures, at its meeting on October 4, 1927, adopted provisionally a temperature scale, including certain standard temperatures, interpolation formulae, and methods of measurement. This scale will be used by the Bureau of Standards and other national laboratories.

In addition to the melting and boiling points of water (0° and 100°), the standard temperatures adopted are:

(a) Boiling point of oxygen	−182.97° C.
(b) Boiling point of sulphur	444.60
(c) Melting point of silver	960.5
(d) Melting point of gold	1063

The platinum resistance thermometer is standard below 660° C., the platinum rhodium thermocouple between 660° C. and 1063° C. Above 1063° C., the temperature scale is based on the Wien-Planck equation with $c_2 = 1.432$ cm degrees. There is also included a series of temperatures for calibrating secondary measuring instruments, and details of experimental technique.

The complete text of the decisions of the conference will appear in the October number of the Bureau of Standards *Journal of Research*.

GEORGE K. BURGESS

NATIONAL BUREAU OF STANDARDS

THE NAVAL GRAVITY DETERMINATION SURVEY

LAST fall the International Geodetic and Geophysical Union communicated with the Navy Department on the subject of contributing to an oceanic gravity determination survey, but the initiation of such work without a background of technical experience and with no apparatus to start with presented such difficulties as necessitated a more or less indefinite postponement of any participation. Fortunately, however, Dr. William Bowie, chief of the division of geodesy of the U. S. Coast and Geodetic Survey, learned from Dr. F.

A. Vening Meinesz, of the Netherlands Geodetic Commission, that the latter would be willing to instruct representative scientists in the United States in the technique of his methods of determining gravity at sea, if afforded the opportunity. A conference of those interested followed and the Secretary of the Navy designated the Naval Observatory as his agency in arranging for an expedition of instruction. The problem of securing Dr. Meinesz's invaluable services without too much international formality was happily solved by the Carnegie Institution of Washington, with the approval of whose president it was made possible for Dr. A. L. Day, the director of the Geophysical Laboratory, to extend an invitation to Dr. Meinesz to visit the United States with his entirely unique pendulum apparatus and supervise the instruction in its use so highly desirable before this country should participate in the oceanic gravity determination work which the International Geodetic and Geophysical Union is fostering.

The Secretary of the Navy has assigned the United States Submarine S-21 to conduct the sub-surface work of the expedition and has set aside a period of about two months for the expedition which will establish a series of gravity stations embracing the Atlantic continental shelf south of the Chesapeake Capes, the Gulf of Mexico, with emphasis on the Mississippi delta, the Bartlett Deep south of Cuba, and particularly the Nares Deep adjacent to Porto Rico. Besides Dr. Meinesz, who will supervise the pendulum determinations, there will accompany the expedition Dr. Frederick E. Wright, of the Geophysical Laboratory of the Carnegie Institution, and Elmer B. Collins, principal scientist, of the Hydrographic Office, Navy Department. The S-21 is being accompanied by the United States Eagle Boats Nos. 35 and 58, and Lieutenant-Commander T. L. Nash, U. S. Navy, commands the expedition, while Lieutenant J. L. Fisher, U. S. Navy, commands the submarine itself.

Before the departure of the expedition from the Washington Navy Yard, an opportunity was given to members of the various scientific bodies in Washington to view the pendulum apparatus in place aboard the S-21, while Dr. Meinesz explained its workings.

Upon his return from the expedition in December, Dr. Meinesz will deliver a lecture in Washington on the apparatus, the general character of its results and on the features of scientific interest that develop during the current cruise.

Since the above was written word has reached the Navy Department of a successful run from Hampton Roads to Key West of the naval gravity determination expedition, consisting of the submarine S-21 and two Eagle boats acting as tenders.

Provisional results obtained by Dr. Vening Meinesz, the distinguished Dutch geodesist, from his comparisons made in Washington between his special apparatus and the standard pendulum apparatus used by the Coast and Geodetic Survey show variations only in the millionth place of the computations, which is naturally very satisfactory, especially as the results are subject to still greater refinement, when the rates of the clocks employed are more exactly determined.

Three gravity stations were established off the Atlantic Coast during the cruise south to Key West. On Thursday, October 11, the expedition left Key West for Galveston via the Sigsbee Deep in the western part of the Gulf of Mexico. The expedition was due in Galveston on the 17th instant for refueling and minor overhaul work.

Dr. Meinesz expresses his special gratification over the cooperation of officers and men of the expedition.

C. S. FREEMAN
U. S. NAVAL OBSERVATORY

DEDICATION OF THE SHANKLIN LABORATORY OF BIOLOGY AT WESLEYAN UNIVERSITY

THE Shanklin Laboratory of Zoology forming the third quarter of the new Johnston quadrangle at Wesleyan University was dedicated with appropriate ceremonies on October 12.

Professor Charles M. Child, of the University of Chicago, delivered an address on "The Individual as a Biological Problem." Immediately afterward the memorial tablet opposite the main entrance on the first floor of the laboratory was unveiled by a member of the late President Shanklin's family.

Following is the inscription on the memorial tablet in the new building:

SHANKLIN LABORATORY OF BIOLOGY
A MEMORIAL TO
WILLIAM ARNOLD SHANKLIN, D.D., LL.D.
PRESIDENT OF WESLEYAN UNIVERSITY
1909–1923

Professor Edwin G. Conklin, of the department of biology at Princeton University, delivered an address in the evening on "Biology and Human Life" in Memorial Chapel.

President James Lukens McConaughy presided at the ceremony in the afternoon in the Shanklin Laboratory. A brief description of the new science hall was given by Professor Edward Christian Schneider, professor of biology, followed by the introduction of Professor Child, a member of the class of 1890.

A buffet supper was served for specially invited guests.

Shanklin Laboratory is the fourth of four recent building additions to the University, including Olin Memorial Library, Hall Laboratory of Chemistry, and the Harriman dormitory. The new structure, built of Harvard brick and Imperial Danby marble, presents a striking effect on the hill east of Hall Laboratory along Wesleyan Place. The building is 124 feet long and fifty-five feet wide, containing four floors. A greenhouse which is also used as a vivarium is attached to the south end. Outdoor pools for fish and aquatic vegetation are in an open air court surrounding the greenhouse.

A lecture room seating 160 men is on the east side of the ground floor, and adjacent to this a preparation room in which charts, lantern slides and other illustrative materials will be stored. An herbarium room, drafting room, aquarium room and a research room are included in the ground floor. The research room is equipped with apparatus for maintaining constant temperature. Special rain-water storage has been arranged so that tanks and the greenhouse may use pure water, for it is found that city water is injurious to certain kinds of aquatic life.

Accommodations for fifty-six men in general biology classes are included on the second floor in two laboratories. A comparative anatomy laboratory will care for advanced courses of invertebrate and vertebrate zoology. A departmental museum and rooms for teachers and students are included. Histology and embryology rooms are on the third floor, and a suite for bacteriology. A sterilization and media room, an incubator room and refrigerating room adjoin. Besides recitation rooms and a library there is a chemical laboratory for nutrition work. In a well-ventilated area under the roof are two animal rooms, one for small animals such as mice and guinea-pigs and the other for larger animals.

THE NEW YORK MEDICAL CENTER

THE new Medical Center at Broadway and 168th Street, said to be the largest and most modern in the world, was dedicated with appropriate ceremonies on October 12.

After an invocation by the Reverend Dr. Raymond C. Knox, chaplain of Columbia University, General William Barclay Parsons, chairman of the Joint Administrative Board of the Medical Center and of the trustees of Columbia University, explained how the idea of the joint enterprise on the part of the university and the Presbyterian Hospital originated eighteen years ago.

According to the report in the New York *Times*, he said:

> Endless details remained to be solved and, hardest of all, great sums of money to be raised. For the latter we are indebted to many friends, the Carnegie Corporation, the General Education Board, the Rockefeller Foundation and countless others, who made gifts, both large and small, that these buildings might be erected, but the outstanding gift that made the plan possible was that of this site of more than twenty acres by Edward S. Harkness and his mother. To each and every friend I take this public opportunity of again expressing our heartfelt appreciation. . . .
>
> The fruits of eighteen years of labor stand before you. No claim is made that the work is finished, because to the man of science progress has no end, no horizon. The allied institutions offer this first effort as an initial contribution to the relief of suffering humanity in all forms and for all time. As further needs develop a hearty welcome is extended to other institutions to join the group, so that this center shall increasingly represent the high ideals and broad achievement worthy of this city, this state and nation.

General Parsons then named the recipients of honorary degrees as Edward Stephen Harkness, doctor of laws; Dean Sage, president of the Presbyterian Hospital, doctor of laws; James Gamble Rogers, architect of the Medical Center, doctor of science in architecture, and Otto Marc Eidlitz, contractor and builder, doctor of science in construction, and the degrees were conferred by Dr. Nicholas Murray Butler, president of the university. The dedicatory address was then made by Dr. Samuel W. Lambert, dean emeritus of the College of Physicians and Surgeons of Columbia University and president of the New York Academy of Medicine.

The twelve units composing the Medical Center are the Presbyterian Hospital, the College of Physicians and Surgeons of Columbia University, the Sloane Hospital for Women, the New York State Psychiatric Institute and Hospital, the Babies' Hospital, the Squier Urological Clinic, Presbyterian Hospital School of Nursing, the Neurological Institute and Hospital, the Stephen V. Harkness Patient Pavilion, the School of Dental and Oral Surgery, the Vanderbilt Clinic and the De Lamar Institute of Public Health.

Ground for the erection of the Medical Center was first broken nearly four years ago. Since that time the towering buildings have been erected at a cost of about $25,000,000. Further construction, already contemplated, will bring the ultimate cost of the center to $40,000,000.

THE MICHELSON MEETING OF THE OPTICAL SOCIETY OF AMERICA

THE thirteenth annual meeting of the Optical Society of America, to be held in Washington, from October 31 to November 3, under the joint auspices of the

society and the Bureau of Standards, celebrates the semi-centennial of the publication of the first communication on the "Velocity of Light," by Professor A. A. Michelson, "distinguished service" professor of physics in the University of Chicago.

A cordial invitation to attend is extended to all persons interested in optics. The program is distinguished by notable groups of papers on physical optics and biological optics. Among the events scheduled are:

Invited paper by Professor Michelson and his collaborators, Messrs. Pease and Pearson, on "Results of Repetition of the Michelson-Morley Experiment."

Presentation of the Frederick Ives Medal to the society by Dr. Herbert E. Ives.

Motion pictures of the planets made by Professor W. H. Wright at Lick Observatory.

Demonstration of technicolor motion pictures.

The following invited papers will also be presented:

Arthur H. Compton: "X-rays as a Branch of Optics."

C. J. Davisson: "The Scattering of Electrons by Crystals."

Paul R. Heyl: "The History and Present Status of the Physicist's Idea of Light."

Henry Laurens: "The Physiological Effects of Radiation."

John M. Arthur: "Some Effects of Radiation on Plants."

W. J. Crozier: "The Phototropic Behavior of Animals."

F. M. Schertz: "Application of Transmittancy Measurements to Biochemistry."

Selig Hecht: "The Nature of the Sensitivity of Animals to Light." (At a joint meeting of the Philosophical Society of Washington and the Biological Society of Washington to which members of the Optical Society are invited, Saturday, 8:15 P. M.)

Leonard T. Troland: "Optics as Seen by a Psychologist."

The sessions of the Optical Society for the presentation of papers are limited to three days, November 1, 2, 3; but it is suggested that those who desire full opportunity to visit the exhibition, inspect the laboratories of the Bureau of Standards, and visit the other institutions of interest to them, without missing sessions of the society, will do well to plan their sojourn in Washington from October 31 to November 5, inclusive. It has been arranged to have the Optical Exhibition open at 9:00 A. M., Wednesday, October 31; and the Bureau of Standards particularly invites visitors to inspect the optical equipment in its laboratories on both Wednesday, October 31, and Monday, November 5.

The Optical Exhibition will be comprehensive and will include not only instruments of current interest but also a historical exhibit on the microscope and an exhibit of books and portraits, and optical instruments *in situ* at the Bureau of Standards. Wardman Park Hotel, situated near the Bureau, will be the headquarters for the meeting.

SCIENTIFIC NOTES AND NEWS

DR. FRANKLIN H. MARTIN, of Chicago, has been elected president of the American College of Surgeons, which he organized in 1913.

DR. ZAY JEFFRIES, of Cleveland, consulting metallurgist of the Aluminum Company of America, was nominated at the recent Philadelphia meeting for the presidency of the American Society for Steel Treating.

DR. O. DE VRIES, director of the Rubber Experiment Station at Buitenzorg, Java, has been appointed president of the fourth Pacific Science Congress to be held at Batavia from May 16 to 25, 1929. He succeeds Dr. A. A. L. Rutgers, director of the Department of Agriculture, Industry and Commerce of the Dutch East Indies, who has resigned to accept an appointment as governor of Surinam.

DR. WILLIAM H. WELCH, professor of the history of medicine at the Johns Hopkins Medical School, has returned to the United States after a visit of sixteen months abroad.

DR. H. T. CLARKE, who recently resigned from the department of synthetic chemistry of the research laboratory of the Eastman Kodak Company to accept the position as head of the department of chemistry of the College of Physicians and Surgeons of Columbia University, was given a farewell dinner at the Rochester Club by officers and past officers of the American Chemical Society.

DR. PARK LEWIS, of Buffalo, first vice-president of the Society for the Prevention of Blindness, has been given the Leslie Dana medal awarded annually for the most outstanding achievement in the prevention of blindness and the conservation of vision in America. The presentation took place at the meeting of the American Academy of Ophthalmology and Otolaryngology in St. Louis on October 18.

FRANKLIN AND MARSHALL COLLEGE, Lancaster, Pennsylvania, has conferred the honorary degree of D.Sc. upon Dr. Wm. A. Kepner, professor of biology in the University of Virginia.

PROFESSOR FRANK B. MORRISON, director of the New York State Agricultural Experiment Station at Geneva, N. Y., has been appointed head of the department of animal husbandry in the College of Agriculture, Cornell University, to succeed Professor Henry

H. Wing, who retired last year with the rank of emeritus professor after a teaching career of forty years. Dr. U. P. Hedrick, since 1905 head of the division of horticulture at the New York State Agricultural Experiment Station and, since 1921, vice-director, has been elected director of the station.

DR. ROBERT D. GLASGOW has been appointed New York state entomologist to succeed Dr. E. P. Felt, who retired on April 1, after thirty-three years' service. Dr. Glasgow comes from the University of Illinois, where he served on the teaching staff of the university and on the State Natural History Survey for over eighteen years.

JOHN W. FREY, for the past eight years connected with the department of geography of the University of Wisconsin, will begin on November 1 his work as chief of the coal and petroleum section of the bureau of foreign and domestic commerce at Washington.

WILLARD N. CLUTE, editor of *The American Botanist,* has joined the botanical staff of Butler University as director of the Botanical Gardens.

THE Rosenwald Industrial Museum of Chicago is to proceed at once with the development of a division of physics and chemistry. The appointment of Dr. Andrew M. MacMahon, from the Ryerson Laboratory of the University of Chicago, to take charge of this work is announced. In the absence of the director of the museum, Mr. Waldemar B. Kaempffert, who will spend the coming months abroad investigating the problems of similar European institutions, Dr. MacMahon will serve as acting director.

REAR ADMIRAL CARY T. GRAYSON, who was physician to President Woodrow Wilson, was elected president of the Gorgas Memorial Institute of Tropical and Preventive Medicine, at the annual meeting of the institute held on October 10. He succeeds Dr. Franklin H. Martin, of Chicago. The scientific board of the institute includes the following members: Captain Charles S. Butler, M. C., U. S. N., Washington, D. C.; Dr. Bowman C. Crowell, professor of pathology in Jefferson Medical College, Philadelphia; Dr. W. G. MacCallum, of the Johns Hopkins University; Dr. G. W. McCoy, U. S. Public Health Service, Washington, D. C.; Lieutenant Colonel J. F. Siler, M. C., U. S. A., Washington, D. C.; Dr. Richard P. Strong, of Harvard Medical School; Dr. C. C. Bass, dean of the school of medicine of Tulane University.

RESIGNATION of Samuel K. Lothrop from the directorship of the Peabody Museum of American Archeology and Ethnology is announced. Dr. Lothrop was to have taken office September 1, but never assumed the duties of his position. The functions of the office are temporarily being discharged by Dr. Edward Reynolds, associate curator. Dr. Lothrop was preceded in the Peabody Museum by C. C. Willoughby, who, after serving as director since 1915, resigned last January.

DEAN WILLIAM MCPHERSON has resigned the chairmanship of the chemistry department of the Ohio State University, in order that he may devote practically all his time to the upbuilding of the graduate work of the university. He will, however, retain his chair of organic chemistry. He will be succeeded as chairman of the department by Dr. Wm. Lloyd Evans. In accepting Dr. McPherson's resignation the board of trustees passed the following resolution: "That the board of trustees expresses to Professor William McPherson its deep appreciation of the high quality of the service he has rendered as chairman of the department of chemistry through the years beginning in 1894. The board realizes that the very extensive and intensive growth of the department in the number and the quality of its courses and in the interest of the students, and the very high rank which the department has attained, are primarily due to the constructive policies pursued by Professor McPherson and to his rare ability to do a very large volume of work and a rare grade of teaching himself and at the same time to make skilful selection of the department staff and to inspire the members with his own enthusiasm. For his outstanding accomplishments in this great field of science the university will forever hold Professor McPherson in the highest esteem."

RECENT appointments to scientific and technical departments made by the Secretary of State for the Colonies, as reported in *Nature,* include four superintendents to the Agricultural Department, Nigeria, namely, Mr. O. J. Voelcker, Mr. G. N. K. Turnbull, Mr. J. H. Palmer and Mr. E. W. Leach. Mr. E. S. Morgan is appointed a produce inspector to the same department. A forest surveyor, Mr. J. Brushwood, and a veterinary officer, Mr. W. G. McKay, have been appointed to Kenya Colony. Mr. G. Cowan has been appointed superintendent to the Gold Coast Agricultural Department; Mr. H. Bruins-Lich, horticulturist, St. Helena; Mr. H. P. Smart, agricultural officer, British Honduras; Mr. E. E. Martyn, botanist and mycologist, British Guiana. Six of these appointments are of scholars selected for two years' training in Great Britain and at the Imperial College of Tropical Agriculture, Trinidad, under the Colonial Office Agricultural Scholarship Scheme, whose course finished last June. Amongst the transfers notified is that of Mr. C. W. J. Line from the Gambia to the Gold Coast Agricultural Department.

SIR ERNEST RUTHERFORD, F.R.S., president of the Royal Society, is undertaking the chairmanship of a committee, under the auspices of the minister of health, which will, among other things, make geologic and chemical inquiries in the hope of obtaining radium from the British Empire.

PROFESSOR J. B. SHAW, head of the department of ceramic engineering in the school of mines and metallurgy of the Pennsylvania State College, has been appointed chairman of a committee for research work to be conducted by the National Brick Manufacturers Association. Professor Shaw's committee will work on power generation and its application to this industry.

DR. C. F. MARBUT, chief of the division of soil survey of the U. S. Department of Agriculture, who was severely injured in an automobile accident near Redfield, South Dakota, in July, while on a general inspection trip with T. D. Rice, an inspector of the survey, has recovered and has returned to his office in the bureau in Washington.

DR. HILDING BERGLUND, of the University of Minnesota Medical School, is in Peking, China, for a year as visiting professor of medicine under the Rockefeller Foundation at the Peking Union Medical College.

DR. R. H. HUNTER, lecturer in anatomy at Queen's University, Belfast, and examiner in anatomy for the primary fellowship of the Royal College of Surgeons of Ireland, is visiting the United States as a traveling fellow of the Rockefeller Foundation. He will spend most of his time in studying problems in human embryology at the Carnegie Laboratory of Embryology, Baltimore.

DR. SAMUEL C. PALMER, professor of biology and head of the department of botany and embryology at Swarthmore College, has returned to his work after a year's leave of absence spent on the Continent and in Great Britain.

PROFESSOR WILLIAM SEIFRIZ, of the department of botany of the University of Pennsylvania, spent the summer at work in the Pasteur Institute, Paris. Later he visited England, where he attended the Cancer Congress as a representative of the University of Pennsylvania.

DR. KARL FRIEDERICHS, of the University of Rostock, Germany, is giving the lectures in the graduate course on the principles of applied entomology at the University of Minnesota. These lectures were given last year by Professor R. A. Wardle, of the University of Manchester, England.

PROFESSOR ARTHUR W. ASHBY, of University College, Aberystwyth, Wales, lectured on "Agricultural Trends in Great Britain," under the auspices of the Graduate School of the Department of Agriculture on October 10.

DR. WILLIAM H. HATFIELD, of England, gave the Campbell memorial lecture before the recent Philadelphia meeting of the American Society for Steel Treating.

CLARENCE WENTWORTH MATHEWS, head of the department of horticulture at the University of Kentucky, died at his home in Lexington, Kentucky, on September 23 at the age of sixty-seven years.

DR. NOEL PATON, formerly regius professor of physiology in Glasgow, died suddenly on September 30 at the age of seventy years. He had retired from his chair only a short time ago.

PROFESSOR ALBERT ROBIN, honorary professor in the faculty of medicine of the University of Paris, known for his researches on the interrelations of chemistry and therapeutics, died at Dijon on September 23, in his eighty-second year.

DR. WILHELM WIEN, professor of physics in the University of Munich, died on August 30 at the age of sixty-five years.

THE Association of Official Agricultural Chemists will hold its forty-fourth annual convention in Washington, D. C., from October 29 to 31. This association includes in its membership federal and state chemists engaged in agricultural and food and drug chemical work. Secretary Jardine will address the chemists on October 30, and Dr. H. W. Wiley, honorary president of the association, former chief of the former Bureau of Chemistry, is also scheduled to speak on that day. Dr. Oswald Schreiner, biochemist of the Bureau of Chemistry and Soils, is president of the association, and Dr. W. W. Skinner, assistant chief of the division of chemical and technological research, Bureau of Chemistry and Soils, is secretary-treasurer.

THE twenty-fifth anniversary of the foundation of the German Institute for Investigation of Cancer, which is attached to the Charité Hospital in Berlin, was recently celebrated by a special meeting under the presidency of Professor Friedrich Kraus.

AN International Congress of Museum Directors was recently held in Budapest. Sixty foreign guests were present, among them from England Mr. Robert Hobson, keeper of the department of ceramics and ethnography in the British Museum, and Mr. Eric Maclagan, director and secretary of the Victoria and Albert Museum.

THE University of Michigan Observatory has received a gift of $15,000, the income from which will be used for astronomical publications or research fellowships at the discretion of the director. The donors, Mrs. O. B. Wheeler and family, have made this gift as a memorial to Orlando B. Wheeler, formerly a member of the staff of the University of Michigan Observatory and subsequently engaged in the scientific researches of the U. S. Lake Survey.

DR. GEORGE VAILLANT, of the American Museum of Natural History, has returned from a preliminary archeological survey of Middle America, supported by Mr. Clarence L. Hay. He has obtained a permit from the Mexican government for excavations in the Valley of Mexico for next winter, political conditions permitting. At the invitation of the Carnegie Institution, Dr. Vaillant carried out a small excavation at their site of Uaxactun, Petan, Guatemala, that yielded important information on the early history of the Maya. He was enabled, through the courtesy of the Mexican government, to bring back a small synoptic collection of the "Archaic" cultures of the Valley of Mexico. He also visited a number of sites on the highlands of Mexico and Guatemala, as well as in British Honduras and the Petan district of Guatemala.

Nature reports that owing to the regulations governing the introduction of scientific films into Great Britain, the paper by Professor Rathjens on his explorations in Arabia had to be withdrawn from the program of the recent International Congress of Orientalists at Oxford. The Chancellor of the Exchequer has conceded that scientific films may be brought into England free of duty on a certificate from the Royal Society to the customs authorities that the film illustrates a scientific investigation. Notwithstanding the fact that Professor Rathjens on August 9, and the secretary of the congress on August 10, had made application to the commissioners of customs for the admission of the film, and application was addressed to the Royal Society for the desired certificate, the customs authorities were prepared to admit the film only on a deposit of the duty, £31, 10s., "to be refunded in the event of the film being certified by the Royal Society."

UNIVERSITY AND EDUCATIONAL NOTES

AN offer of approximately $3,500,000 has been made by the International Education Board to the University of Cambridge to provide for the development of physical and biological studies and for a new library.

GIFTS amounting to $500,000 and bequests of $1,830,000 to Columbia University have been announced. The bequests are payments on legacies made by the estates of F. Augustus Schermerhorn, Stephen Whitney Phoenix and Mary B. Pell. Mrs. Nathan J. Miller, of New York, gave $250,000 to endow a chair for the study of Jewish literature and history.

DR. M. C. TANQUARY has accepted an appointment as professor of entomology in charge of apiculture at the University of Minnesota.

DR. MILTON METFESSEL, for three years National Research fellow in psychology, has been appointed associate professor of psychology and phonetics in the State University of Iowa.

DR. ADRIANCE SHERWOOD FOSTER has been appointed assistant professor of botany at the University of Oklahoma. Dr. Foster has been working as a National Research fellow in plant anatomy at the University of Leeds, England.

DR. M. G. PETERMAN, of the Milwaukee Children's Hospital, has accepted the appointment of professor of pediatrics and head of the department of pediatrics at Marquette University School of Medicine, Milwaukee.

DR. FRED W. STEWART, recently assistant in pathology in the Rockefeller Institute, has become associate pathologist in the Cornell Medical College in New York and assistant pathologist at the Memorial Hospital for Cancer and Allied Diseases.

AT Swarthmore College, Dr. H. J. M. Creighton has been promoted to a professorship and made head of the department of chemistry. Dr. Duncan Graham Foster, of St. Stephen's College, has been appointed associate professor of chemistry. Dr. John H. Pitman has been promoted to an associate professorship of mathematics and astronomy.

DR. ERNEST CARROLL FAUST, director of the laboratory of parasitology of the Peking Union Medical College, Peking, China, since 1919, has taken up his new work as professor of parasitology in the department of tropical medicine of Tulane University, New Orleans. Dr. John F. Kessel, formerly associate in the Peking laboratory, is now associate professor of zoology in the University of California at Los Angeles.

DISCUSSION AND CORRESPONDENCE

DOES PURE IRON HAVE ALLOTROPIC TRANSFORMATIONS?

EXTENSIVE work on iron and iron-alloys led the writer to announce the following hypothesis before

the joint meeting of the Pittsburgh sections of the American Electrochemical Society and the American Institute of Mining and Metallurgical Engineers in January, 1925, but so far not otherwise published:

α-iron (body-centered cube) is the characteristic form of the iron crystal and can exist at all temperatures below the freezing-point.

α-iron can hold impurities such as carbon, oxygen, etc., in solution, the parasitic atoms occupying the interstitial spaces in the iron lattice, and the amount held in solution depending upon the temperature. If the amount exceeds the solubility for the particular temperature, the impurities may be precipitated, or they may cause the iron to change its modification to the γ state (face-centered cube) in which form it can hold a larger amount of impurities in solution.

The bases for this hypothesis are discussed in a paper now being prepared for publication, but they may be stated here briefly:

(1) All iron so far experimented with contains impurities to a greater or less extent, particularly carbon and oxygen. Electrolytic iron, extensively used for transformation point determinations, contains oxygen to the extent of about 0.4 per cent., and all such determinations are consequently made with iron more or less saturated with oxygen in solution. The lower the carbon content the higher is probably the oxygen content.

(2) The addition of silicon (a substitution atom in the lattice and a strong deoxidizer) to the extent of 1.5 to 2 per cent., eliminates the transformations from α- to γ-iron. This is a well-established fact. We have now found that the lower the carbon content the lower is the amount of silicon necessary to eliminate the transformations. Extrapolating to zero carbon content (or $C < 0.001$ per cent.) it seems logical to suppose that the amount of silicon necessary to eliminate the transformations should be zero in the absence of oxygen, *i.e.*, for pure Fe we should have no allotropic transformations.

Equilibrium diagrams based on the above hypothesis have been drawn and are not contradicted by present experimental evidence or by theoretical reasoning. Efforts are being made to produce samples of iron very low in carbon and oxygen that can be used in confirming or invalidating this hypothesis, and cooperation by others is invited, especially by those having first-class facilities at their disposal.

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WEATHER PREDICTION AND WEATHER CONTROL

THE recent disastrous hurricane will have made many men willing to listen to a discussion of the possibilities of weather control, and as an introductory to such discussion it is worth while, perhaps, to discuss the possibilities of greatly improved and extended weather forecasts.

Stated mathematically, the forecast problem is approximately as follows: Consider the data a, b, c, d, etc., which represent the state of the weather over an extended area at a given instant; these data would consist of, let us say, 10,000 separate quantities (temperatures, air pressures, velocities of wind, directions of wind and humidities; at various points on the ground and at various elevations). Consider the similar quantities x, y, z, etc., which represent the state of the weather after t hours, where t is of course specified. The first approximation to the actual behavior of the atmosphere is to assume that x, y, z, etc., are *linear* functions of a, b, c, etc., and t, and the constant coefficients are supposed to have been found for the various seasons of the year. Then the problem would be to solve the 10,000 simultaneous linear equations for the 10,000 unknowns, x, y, z, etc. This solution would be utterly impracticable unless Lord Kelvin's machine for solving simultaneous linear equations could be made to be practicable for 10,000 simultaneous equations, which is extremely doubtful. The "constant coefficient" could be determined by observing x, y, z, etc., at time t.

The above suggestion[1] is exactly equivalent to the laborious calculation which has recently been made by Louis F. Richardson,[2] who assumed certain linear differential equations as expressing the laws of motion of the atmosphere and found x, y, z, etc., by integrating these differential equations over time t starting from the given state a, b, c, d, etc. This was a labor of several months where t was only one day (24 hours)! That is to say, it took three or four months to calculate the weather one day in advance! Weather forecast by straightforward calculations seems to be impracticable—and it must be remembered that the straightforward calculation is based on assumed linearity.

A third method of forecast would be to let the weather be its own integrating machine! Suppose a very elaborate study of the weather over the United States were to enable us to classify general weather conditions as 1,000 type-series, each series being a succession of states extending over 20 days (the numbers 1,000 and 20 are taken for the sake of illustra-

[1] Made to the writer by Professor Norbert Wiener.

[2] "Weather Prediction by Numerical Process," Cambridge University Press, 1922.

tion). This would mean 20,000 individual and fairly distinct types. Then from the weather data on any given date we could identify the weather type on that date, and the forecast for a number of days would be the successive stages in the corresponding type-series.

This method of weather forecasting is used at present, but by no means as elaborately as it should be. This I pointed out in a paper in the U. S. *Monthly Weather Review* for October, 1918.

This same paper also contained a suggestion as to a possible method of weather control, and it seems to me to be worth while to enlarge on this suggestion, for, in my opinion, it deserves actual trial. Essentially the method is the use of the "back fire" in the fighting of a prairie or forest fire.

In the first place, the local energy of a storm is undoubtedly derived from the local potential energy of a widespread unstable state, just as the local energy of a line of standing dominoes is derived from the local potential energy of the standing dominoes when the whole line is made to collapse by touching the end domino. Let us discuss the recent Porto Rico and Florida hurricane; of course the discussion will have to be based on assumed data, and we will find that the word control is rather a strong term to use for what might conceivably be accomplished.

The energy of the storm at Palm Beach came undoubtedly from a local region fifty miles or so in radius, and the local energy was released by the progressive and somewhat systematic collapse of a widely extended unstable state of the atmosphere, this progressive collapse being the whole progress of the storm movement from far beyond Porto Rico—very much like the progressive collapse of a row of standing dominoes.

Suppose we could have known of the widespread and threatening unstable state of the atmosphere in the region near the Florida coast a short time before the actual arrival of the storm at Palm Beach, and suppose that we had "touched off" this unstable state at three or four points and at three or four times in the Bahamas and along the Florida coast. We might thus have caused the local energy of the unstable state of the atmosphere to have been frittered away in several *unrelated* storm movements, each of very moderate violence, and no energy would have remained in the neighborhood to support the great systematic collapse which constituted the actual storm.

The knowledge of the threatening state of the atmosphere could certainly have been established by observations in time for the remedial measures; but how to "touch off" the unstable state of the atmosphere—that is the question which must be answered by trial.

The most promising thing to try would be as follows: Suppose that, anticipating the need in the Florida region, we had erected twenty or thirty very large steel cones, fifteen or twenty feet in diameter at the base, forty or fifty feet in diameter at the top, one hundred feet high, and open at the top. These would be distributed thinly over southern Florida and on the Bahama Islands. A large charge of gun powder (a ton or more for a cone) exploded in the base of a cone would drive the air in the cone (60,000 cubic feet of air) upwards as a gigantic vortex ring, or "smoke ring," which would carry a very considerable upward impulse to an elevation of several thousand feet, and thus start a rising column of warm, moist air in the lower strata of the atmosphere. Would this work? Nobody can tell except by trial. Would a trial cost very much? It certainly would cost several millions of dollars. Would a trial be worth while? Ask the people of southern Florida. I am purposely making what seems to me an overestimate of the size of cones required, and perhaps also an overestimate of the number.

WILLIAM S. FRANKLIN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A FURTHER NOTE ON THE DIFFICULTIES ENCOUNTERED BY LAND VERTEBRATES IN THEIR DEVELOPMENT[1]

IN addition to the difficulty presented by the respiratory requirements of vertebrates, in emerging from water to land, one must reckon also the changes which were necessary in the uro-genital system. Further experiment and reflection on the development of the respiratory system have brought out certain new problems with reference to the tenth cranial nerve and its peripheral afferent and central nervous endings. From the point of view of the student of the phylogenetic development of the neuro-muscular mechanisms of respiration, the pulmonary components of the vagus have changed from something which every physiologist and every anatomist thought he knew about to practically unknown territory in the amphibian and in the reptile. The chapter on the respiratory mechanism is thereby lengthened. But coincident with the development of the mechanism which brought about the adjustment of vertebrates to the free, rather than to the dissolved, atmosphere, there were changes in two other systems: one, the development of an epidermis which could survive in an atmosphere containing little water vapor, and, two, the development of a mechanism to protect the young from this atmosphere and its attendant dangers until they had reached a certain stage of development. The fertilization of the ovum floating free in the

[1] F. H. Pike, SCIENCE, 59: 402, 1924.

water by sperm also floating free in the water was no longer possible in land vertebrates. From the knowledge gained by study of the development of the respiratory mechanism,[2] one may look forward to finding a similar extensive and profound change in the neuro-muscular as well as glandular mechanisms in the development of the reproductive system of land vertebrates. The internal fertilization of the ovum and its subsequent encasement in a calcareous shell is, indeed, an advance shown by reptiles and birds over fish and amphibians. The process seemed adequate for the needs of the poikilothermal reptiles which left the eggs in the sand and fared forth in search of food. With the development of homoiothermal conditions in birds the sand no longer possessed sufficient constancy of temperature. Nest-building, incubation and the consequent restriction of range during the period of incubation were necessary developments. The restriction of range would be a serious handicap to any form in which search over a considerable region is necessary for obtaining food and water. The viviparous habit, appearing sporadically in fish and reptiles, has become constant in mammals. It is difficult to imagine animals with the other characteristics of mammals but without the viviparous habit or without the development of the reproductive system of mammals.

From the point of view of the student of comparative physiology we have, in the development of the reproductive system, a shifting of old afferent, efferent and central nervous endings as well as the development of new nervous and muscular structures which is at present an unknown and unworked field. The fundamental biological need for sex arose much lower in the animal phylum than the vertebrates and seems to me to be related more to the problem of regulation of body form[3] than to some of the other phenomena which have been associated with it in biological thought. The failure of parthenogenesis in all but the simpler forms becomes intelligible or understandable when considered in relation to regulation of body form. The thing to be explained about parthenogenesis seems not so much its occurrence in some forms as its absence in the higher forms. Regulation of body form implies a regulation of some sort of growth and development of all the constituent cells of the organism. Such control would obviously be impossible if ova were parthenogenetic and likely to start development at any time. Control of development, which is a necessary postulate for regulation of body form, means also control of fertilization. Such control of fertilization could hardly exist without sex.

[2] F. H. Pike and H. C. Coombs, Science, 56: 691, 1922. M. G. Springer, "Archives of Neurology and Psychiatry," 19: 834, 1928.

[3] F. H. Pike, *Ecology*, 4: 420, 1923.

F. H. Pike
Columbia University

THE INVENTION OF THE DYNAMO

The mistake that was noted in Science concerning the celebration last spring by the Franklin Institute has been corrected by Dr. Thomson's letter. It will be interesting, I think, to give some data as to the first dynamo of which there is positive information. This was constructed by Joseph Saxton, an American, resident at the time (1833) in England. He presented a description of it to the British Association for the Advancement of Science at its meeting that year. The original instrument is now in the collection of the Franklin Institute and is figured, with many other interesting early inventions, in the article I wrote for the booklet published on the occasion (1924) of the Centennial celebration of the founding of the institute.

The *Journal* of the Franklin Institute for 1834 (vol. 17, p. 155) contains an extract of a letter from Saxton to Isaiah Lukens, of Philadelphia, in which he says among other things: "Since writing to you last I have fitted up a magnet, which I believe produces much more powerful electrical effects than any other which has yet been made. It weighs five pounds and a quarter, and has a permanent power capable of supporting ten pounds. By the aid of this magnet, I can decompose water rapidly, and the shocks given to the tongue and mouth are so violent that few will take them a second time."

The investigation as to the efficiency of the dynamos for sale in 1878 was in charge of a sub-committee composed of Messrs. E. J. Houston, Elihu Thomson and Theodore D. Rand. Mr. Rand was in the banking business and was a mineralogist of ability, who industriously searched the vicinity of Philadelphia and enriched the local collections with many valuable specimens. It is stated in the final report that "Mr. Rand's business engagements prevented his taking active part in the work of this sub-committee."

Regarding the dynamos exhibited at the Centennial Exhibition the reports and awards of Group XXV in the official volume published by the exhibition authorities (item 24, page 136) state: "Several specimens of the well known Gramme machine without steel magnet constitute this collection and some of them were shown in action producing the electric light." Another volume of the reports states that one of Farmer's machines was also exhibited.

Henry Leffmann
The Franklin Institute,
Philadelphia

IN the issue of SCIENCE for September 14, Professor Elihu Thomson makes it quite clear that the celebration in Philadelphia last April (referred to in SCIENCE for April 13, May 25 and August 3) was neither in fact nor intent a celebration of the fiftieth anniversary of the *invention* of the dynamo, as had been reported. It was unfortunate that reports misled some of us into believing that this was its intent.

Professor Thomson also calls attention to various magneto-electric machines with permanent magnets, preceding the dynamo-electric machines (commonly referred to as dynamos) with electrically excited fields which were shown at the Centennial Exposition in 1876. Electrically excited fields made possible large machines capable of regulation, and their use was an important step in the development of the electrical art of to-day, an art in which Professor Thomson himself has always taken a leading part. The exhibit at the Centennial of the first dynamo-electric machines, two made in France and one in America, was, therefore, of historical importance. So also was the report published by the Franklin Institute two years later on the first scientific tests made on this type of machine. This report is noteworthy and deserving of commemoration.

FREDERICK BEDELL

QUOTATIONS

A MONUMENT TO MEDICINE

DR. SAMUEL W. LAMBERT, in his address at the dedication of the Medical Center, described this monumental group of tall buildings as "a veritable Tower of Babel"—in view of the variety of scientific languages to be spoken there. But with this the analogy ends. The ancient tower failed of completion because of the sudden confounding of tongues. But in this modern community of towers all that the art and the science of medicine have to offer, each in its own speech, is brought together into a unity. This promises to be perpetual, under one roof—a roof so high that, just as the ancients hoped the gods might visit mortals, the builders have made it possible for the heavens to touch mankind with healing.

No such monument has ever before risen to medicine as was dedicated on the western rim of Manhattan Island. Another will soon arise on the eastern rim. Together they will be a vast fortress of defense against disease, and on their towers scientific watchmen will stand not only to give warning but also to fight day and night against the swarming bacterial infections and toxins and heal the wounded. The people of this city and the surrounding region should long be grateful to Mr. Edward S. Harkness and his mother because they kept this site through many years in prospect of such beneficent use, when the plans could be perfected and the funds found for this great enterprise, in which realization he had also a large part. It may be hard for those who have great riches to enter the Kingdom of Heaven, but this achievement demonstrates that it is not an impossibility. The vision of Mr. Harkness has literally brought into the midst of this greatest city a smaller city of refuge which is as one "let down from Heaven."

Its significance, as was again emphasized at the dedication, is that it is devoted to "the trinity of medicine": the care of the sick, research and teaching. This is not by any means unique, but never before have the three services been coordinated in one institution on such a scale and with such endowment and equipment. Even so, it is not as yet complete, and will not be till every specialty of medicine and surgery has not only its dispensary but also its wards for the care of patients, and until provision is also made for dormitories and a common dining-hall for the students of medicine. But what has been already secured is so vast and varied that those who have planned and labored through years must feel that their noble project has been brought to full fruition. The academic degrees bestowed upon them are but a handsel of the praise and gratitude that will be paid in for years to come, and should, in the phrase of Sir Thomas Browne, author of "Religio Medici," make them "happy enough to pity Caesar."—*The New York Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

FURTHER STUDIES IN QUANTITATIVE VIROLOGICAL METHODS

PRELIMINARY studies[1] on the virus of light-green mosaic of tobacco indicated that discrepancies in quantitative tests and variations in the initial concentration of virus in fresh extracts are caused by several factors. The relative importance of some of these factors is being determined.

Quantitative inoculation tests have been made in full and in reduced daylight and in artificial light. Such tests have also been carried out in full daylight at fairly high (77 to 85° F.) and low (55 to 60° F.) temperatures, representing extremes which might be encountered in greenhouses during the year.

The results indicate that the number of mosaic-infected plants which develop is influenced to a less

1 H. H. McKinney, "Quantitative and Purification Methods in Virus Studies," *Jour. of Agr. Research*, 35: 13–38, 1927.

extent by light and temperature than by the amount of inoculum used and the location and the nature of the inoculation incision.

The time required for the first signs of mosaic is prolonged and very irregular in experiments when temperature is low and when the days are hazy. Also leaf mottling is frequently less conspicuous, and considerable leaf deformity frequently occurs when light intensity is low.

A slightly higher percentage of infection has been obtained in young plants than in older plants inoculated by the same method, but the factor of age of the test plants seems to be less important than the inoculation technique in determining the regularity of results.

Inoculations by means of needle incisions have been found less effective when made in the leaf lamina than when made in the midrib. Breaking the trichomes on uniform areas of the leaves by means of a brush dipped in the inoculum produces a higher percentage of infection than do needle incisions through the lamina.

Uniform leaf areas are obtained by means of a circular wire ring 21 mm in diameter. The leaf is held between this ring and a flat metal disc, both of which are soldered to the points of a pair of forceps. The encircled area of the leaf is brushed uniformly with the virus extract. The brush is sufficiently stiff to mutilate the trichomes, but soft enough to prevent rupturing the epidermal layer. The excess extract is removed from the leaf by means of filter-paper or absorbent cotton. This method will be referred to as the ring-brush method.

Experiments have shown advantages in transplanting the test plants into pots three inches in diameter rather than to four-inch pots. As soon as the seedlings are well established in the flats they are transplanted, one in each pot.

When testing extracts known to be of low virus concentration, the plants are inoculated by the needle-cotton method described previously[1] when the tenth leaf is from 2.5 to 5 cm in length, or younger plants are inoculated by means of the ring-brush method. In this case several areas may be so inoculated on each plant if virus of very low potency is being tested, but this procedure is slow.

When testing extracts known to be of fairly high virus concentration, the plants are inoculated when the largest leaf is from 2.5 to 3 cm long. The inoculations are made by puncturing the midrib or the lamina of a leaf with needles which have been dipped into the extract. One needle may be dipped in the extract and inserted into the leaf a given number of times or several needles or insect mounting pins may be mounted in a single handle as suggested by Holmes,[2] thus reducing the number of operations. Five fine needles are used by the writer. Because of the low percentage of infection produced by this method, it is unnecessary to dilute extracts of fairly high virus content as must be done when the more effective inoculation methods are used. It is a rapid method, but the evidence indicates that it is just as subject to experimental variation, if not more so, than the other methods suggested.

Care must be exercised to reduce variation in the amount of fluid which clings to the needles when they are withdrawn from the extract. Tests show that a single fine needle or insect pin withdrawn rapidly may carry as much as fourteen times more extract than the same needle when withdrawn slowly. The average of the tests shows that the quantities of extract on needles withdrawn rapidly and slowly stand in the ratio of 8.38:1, respectively. When attempting to maintain a medium rate of speed for withdrawing the needle from the extract, tests show that the quantity carried on the needle varies from 1 part to as great as 2.78 parts. Less variation occurs when the needle is withdrawn from the extract either rapidly or slowly. The greatest consistency has been obtained when the needle is withdrawn rapidly. Tests on this procedure show that the variation in quantity ranges from 1 part to 1.44 parts.

Care must be exercised in withdrawing needles from the tissue to prevent undue enlargement of the incisions by slight lateral movements. The tender leaf lamina of young plants tears easily if the needles are given a very slight side movement.

No such variations occur in the quantities of extract carried on the cotton used with the needle-cotton method. The quantity used is sufficiently large to enable the worker to gauge regularity surprisingly well with the eye. When the usual care is exercised, the variation in quantity of extract ranges from 1 part to 1.39 parts when the cotton-tipped needle is dipped into the extract. Tests were carried out with amounts of cotton which were obviously larger and also smaller than the amounts regularly used on the inoculation needles. The results show that the largest amount of cotton carries as high as 4.73 times more extract than that carried on the smallest amount. The average of the tests shows that the quantities of extract on large and on small amounts of cotton dipped into the extract stand in the ratio of 2.33:1, respectively.

From these data it appears that the quantity of extract conveyed to the plant can be regulated in a satisfactory manner by the needle-cotton method.

[2] F. O. Holmes, "Accuracy in Comparing Various Concentrations of Tobacco-mosaic Virus." (Abst.) *Phytopathology*, 18: 132, 1928.

The number and the location of the incisions used in this method can be regulated without difficulty. When this is done, experiments indicate that the method is as accurate as any yet devised for mosaic transmission, and it has advantages over any other yet devised for studying fractions containing small amounts of virus.

The three inoculation methods under discussion are all useful for certain types of work and a virus-unit system is being developed for each of them.

As these studies progress it becomes increasingly evident that all the factors which influence the quantitative tests should be controlled as far as practicable. In this way the most satisfactory results are obtained with a minimum number of test plants.

It has been found advantageous to conduct some of the quantitative inoculation tests and certain other mosaic studies in rooms illuminated only by controlled electric light and held at 25 to 27° C. Mazda lamps, and also the Cooper Hewitt mercury vapor work-lamp with glass tube, have been employed as sources. The last-mentioned light is made up of yellow and green bands, also blue and violet bands. No red is present. The plants in these rooms grow more slowly than those receiving sunlight, thus causing the mosaic disease to develop more slowly. Mosaic-free plants grown under mazda lamps produce very long petioles and internodes. The leaves also tend to elongate. The color of the foliage is light green.

Plants cultured under the Cooper Hewitt work-lamp grow in a more nearly normal manner. The petioles and the internodes are comparatively short, the leaves are not excessively elongated, and the green coloration is more nearly normal than that produced by mazda lamps.

The methods commonly used for extracting virus are a source of error when determining the concentration of virus in different tissues. Bursting cells by freezing or by grinding, and the use of the hydraulic press, aid in removing the virus from the tissues. However, even when these steps are followed some virus remains in the press cake, especially if the tissue is of low water content.

To avoid part of this difficulty the following method of extraction is employed. Small representative samples of tissues are obtained. Samples greater than one gram of green weight are avoided if possible. If several samples are taken at one time each is placed in a stoppered weighing bottle. Duplicate samples are taken of each tissue to be tested.

All samples and duplicate samples are weighed to determine the green weights. The duplicate samples are dried to constant weight. In this manner water-content data are made available for the final calculations of the virus concentrations after the completion of the inoculation test.

Immediately after obtaining the green weights of the test samples, the tissue is very thoroughly pulped in a stoneware mortar. In some cases it is frozen before pulping. Sand is not employed unless woody or tough tissues are being studied. A known amount of sterile distilled water is added to the tissue to make a very soft pulp, and evaporation is reduced as far as possible during the pulping process. After the pulping process is completed, additional water of known volume is added to bring the volume in cubic centimeters up to 30 or more times the original weight in grams of the samples of tissue.

The extract contains very small pieces of tissue, plastids, starch grains and finer particles. With the exception of a few plastids and smaller particles, these materials are removed from the extract by means of a laboratory centrifuge. If necessary, the extract may be diluted further for use in the quantitative inoculation tests.

When the water content of the duplicate samples has been determined, the dilutions employed in the tests are corrected on the basis of the excess water added and the total water present in the tissue. After the completion of the inoculation tests, the concentration of the tested virus is calculated if a virus-unit system is used.

Although some extraneous solids remain in the test extract, the error introduced by their presence is relatively small.

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SPECIAL ARTICLES

HUMAN BODY-WEIGHT: I. CORRELATIONS BETWEEN BODY WIDTHS AND OTHER PHYSICAL MEASUREMENTS ON YOUNG MEN

ORIGIN OF DATA

IN October, 1927, the entering men students at Stanford, both freshmen and upper classmen, were given physical examinations under the immediate supervision of Dr. Thomas A. Storey, director of physical education for men. At that time Dr. Storey kindly offered me the opportunity of having certain physical measurements taken under very excellent and uniform conditions. As a result, nearly all the measurements were actually made with the assistance of Dr. Royce R. Long, assistant professor of hygiene and physical education at Stanford. Without the kind cooperation of these colleagues I could not have had these data to subject to statistical study.

THE MEASUREMENTS

In a former paper[1] which dealt with data secured from people who were fasting or on decreased rations and from a group of individuals measured before and after thyroidectomy, it was shown that there are certain body widths as well as heights which demonstrate relatively little change in the presence of rapid changes in body-weight. Notable among these measurements are (1) the maximal diameter at the iliac crests, and (2) the shoulder diameter at the acromions. Total height or stature as well as sitting height also proved to be (as was known) stable measures. Earlier[2] (1922) in connection with an analysis of physical measurements on diabetic patients it was found that body circumferences formed an erroneous basis for predicting normality of body-weight, and it was suggested that the bony diameters should be substituted. Hence in our present investigation it was decided to take measurements of only these four relatively unchanging features along with the body-weight. The men were measured nude after urination and an opportunity for defecation. They had not engaged in heavy exercise previously during the day.

Body-Weight: A carefully standardized, Toledo "No-Springs Scale" graduated in half pounds, was used for the taking of the body-weight measure. Under the conditions employed the weight measurements were probably accurate to one pound, as representing a particular individual's usual weight.

Height: The stature measurement was taken in millimeters. The scale consisted of two meter sticks placed end to end and fastened on a board about three inches wide. This in turn was fastened to a suitable place on the wall, giving vertical and firm support. A small sliding triangle[3] was held in the hand of the observer who slid it along the scale and brought it with proper pressure against the head of the man being measured. The values are probably a little greater than those gotten with the ordinary stadiometer.

Sitting Height: The measurement was made from the floor in the manner described by Dryer.[4] The subjects were required to flex the knees somewhat and to press the base of the spine firmly against the vertical scale before straightening up for measurement. All subjects do not do this equally well; however, the measure as taken on a chair or box is likewise variable, an effect especially due to variability in the voluntary tensing of the gluteal muscles by which the subject can lift the vertex as much as 1 cm. The scale and triangle used for stature were employed for sitting height.

Hip Diameter: The maximal diameter between the outside iliac crests against bony resistance was the measurement recorded. A twenty-four-inch caliper with curved arms (a modified Starrett's outside caliper) was used. The caliper tips were fitted with metal knobs five-sixteenths of an inch in diameter. The instrument was held about horizontal, its apex resting against the belt of the examiner, who, with a hand on each caliper arm, pressed the knobs of the instrument firmly against the bony resistance at the widest point on the iliac crests. The reading was taken *while* the pressure was being applied.

Shoulder Diameter: The caliper knobs were pressed firmly against the acromion processes and the distance measured, during pressure, between the superior external borders. It has been found convenient for the examiner to stand on a small stool so that he may look down on the shoulders of the examinee and on the scale of the caliper held about horizontally.

With the aid of a clerk to record the values as they are called off, and with the men coming up in line, this short series of measures requires a little less than 2′ per man.

THE RESULTS

Foreigners are not included in the results reported in the following tables. The report covers 552 young American men, active and in good health at the beginning of the autumn quarter of the university year, 1927–28. The theoretically equivalent sub-groups were made as follows: the names and data had been copied in one alphabetical list in a note-book of such size as to accommodate nineteen names per page. The men whose names occurred on odd numbered pages were taken as the Odd Group (280) and those found on even numbered pages as the Even Group (272). It was supposed that this would provide random sampling. As it turns out, although each sub-group is rather large, there are in certain instances differences between the groups that exceed the probable error values for the means of either group.

[1] Miles, W. R., and Root, H. F., "Weight and Physical Measurements after Thyroidectomy," *Arch. Inter. Med.*, 1927, 39, 605–617.

[2] Root, H. F., and Miles, W. R., "Physical Measurements of Diabetic Patients, with a Discussion of Normal Weight Standards," *Jour. Metab. Research*, 1922, 2, 173–197.

[3] Miles, W. R., and Root, H. F., "A Simplified and Trustworthy Means of Measuring Stature," *Boston M. & S. J.*, 1925, 192, 111–112.

[4] Dryer, G., and Hanson, G. F., "The Assessment of Physical Fitness," London, 1920. Reprinted by Hoeber, New York, 1921.

The Even Group shows the greater range (Table I) in weight, sitting height, shoulder breadth and age.

TABLE I

THE OBSERVED RANGES FOR CERTAIN PHYSICAL MEASUREMENTS TAKEN ON A GROUP OF UNIVERSITY MEN

Measurement	Odd	Even
Weight (pounds)	103–188	93–225[1]
Height (cm)	159–197	159–193
Sitting ht. (cm)	80– 98	78– 98
Shoulders (cm)	30– 42	32– 45
Hips (cm)	23– 33	24– 34
Age (years)	16– 41	15– 46[2]

[1] Even range would be 103–188 except for one man at 93 and one at 225.

[2] Many at 16 but only two at 15.

TABLE II

THE MEANS AND VARIABILITY VALUES FOUND FOR SOME PHYSICAL MEASUREMENTS ON YOUNG MEN

Odd 280 men	Mean	PE_M	σ	PE_σ	$V=\frac{\sigma}{M}\times 100$
Age (yrs.)	19.6				
Weight (lbs.)	140.3	± .63	15.7	± .45	11.2
Height (cm)	175.8	± .26	6.4	± .18	3.6
Sitt. ht. (cm)	88.7	± .13	3.1	± .09	3.5
Should. (cm)	37.3	± .08	2.1	± .06	5.6
Hips (cm)	27.9	± .06	1.5	± .04	5.5
Even 272 men					
Age (yrs.)	19.7				
Weight (lbs.)	142.4	± .68	16.7	± .48	11.8
Height (cm)	176.2	± .24	5.8	± .17	3.3
Sitt. ht. (cm)	88.9	± .13	3.2	± .09	3.6
Should. (cm)	37.5	± .08	2.1	± .06	5.5
Hips (cm)	27.9	± .06	1.5	± .04	5.5

TABLE III

THE INTERCORRELATIONS OF FIVE PHYSICAL MEASUREMENTS ON YOUNG UNIVERSITY MEN

Odd 280 men	Weight	Height	Sitt. Ht.	Shoulders
Height (cm)	.55 ± .03			
Sitt. ht. (cm)	.52 ± .03	.70 ± .02		
Should. (cm)	.44 ± .03	.33 ± .04	.26 ± .04	
Hips (cm)	.58 ± .03	.53 ± .03	.45 ± .03	.30 ± .04
Even 272 men				
Height (cm)	.53 ± .03			
Sitt. ht. (cm)	.50 ± .03	.71 ± .02		
Should. (cm)	.47 ± .03	.34 ± .04	.32 ± .04	
Hips (cm)	.51 ± .03	.45 ± .03	.42 ± .03	.24 ± .04

The range is the same (13 cm) for hips, but the Odd Group has some taller men, although the mean for height is a little greater for Even. The group averages and variability values are given in Table II. The men were about nineteen years old. There were a very few graduate students who were several years older. The two portions of Table II correspond closely with the exception of weight where there is a difference between group means of 2.1 pounds. This is seen to be three times the size of the probable error of either weight mean. The Even Group also has the larger mean for height, sitting height and for shoulders, but the means for the hip measurement are the same. Davenport and Love[5] for white American troops found an average weight of 144 pounds and height of 172.0 cm. The sitting height taken on a stool was 90.4, shoulder width 41.8 and pelvic diameter 29.4 cm. The two latter measurements were taken with a straight arm caliper. Gray and Mayall[6] for 229 white American men, average age twenty-six years, found the average height 171.0 cm and average weight stripped 141 pounds. The Stanford group is thus somewhat younger, taller, the same weight as the group measured by Gray and Mayall, but lighter than the average soldier.

Comparing the various means with their standard deviations we find in the extreme right hand column of Table II the coefficients of variability, which closely resemble the values previously published for such measures. Davenport and Love have found the following: body-weight 11.7; height 3.9; sitting height 3.9; shoulders 5.8 and pelvic diameter 9.7. The latter was not a bony diameter, hence its variability reflects more typically the weight and is considerably larger than the value we have found for hips. The two portions of Table II correspond quite closely in these variability values and are typical of all published data. Weight is always the most variable and usually height the least. The same relation applies to the human skull as shown by Pearl.[7] The skull capacity is more variable than linear skull measurements, such as breadth, height or length. My colleague, Professor Weymouth,[8] has shown the same

[5] Davenport, C. B., and Love, A. G., "Army Anthropology," Washington, D. C., Gov't. Printing Office, 1921, p. 234, table 103.

[6] Gray, H., and Mayall, J. F., "Body Weight in Two Hundred and Twenty-Nine Adults, Which Standard is the Best?", *Arch. Inter. Med.*, 1920, 26, 133–152.

[7] Pearl, R., *Biometrika*, 1905–1906, 4, 31. Cited by Miner, our reference No. 9.

[8] Weymouth, F. W., "The Life-history and Growth of the Pismo Clam," State of Calif. Fish and Game Commission, Fish Bulletin No. 7, Sacramento, 1923, see pp. 20–21.

fact in his measurement of clams. He was apparently the first to point out that the higher variability for weight was a result of the simple mathematical relation that weight is a three-dimensional character. From a series of clams measured in 1918 he got a mean weight of 41.2 grams, coefficient of variability of 18.5; for the length 6.3 cm, v. 6.3; height 4.7 cm, v. 6.7; thickness 2.9 cm, v. 8.3. The variability of length cubed is 19.5, and of length × height × thickness 18.9. Miner[9] follows something of the same reasoning in comparing variabilities of weight with linear measures. Nevertheless, as we have pointed out elsewhere,[10] it seems anomalous to take the least variable human measure and make it the sole basis for predicting normality in the most variable, especially when shoulders and hips stand fairly midway between height and weight in variability and therefore may reasonably be assumed as more representative of the body build and hence of the normal body-weight than is height alone. Professor T. Wingate Todd in a personal communication has pointed out the necessity that the measurement of the smaller linear distances will have somewhat higher variability due to the fact that the observational error, for example, from using a millimeter scale, will be a larger percentage of the mean. It appears doubtful if this alone can account for the difference, as shown in Table II, between shoulders and hips on the one side as against height and sitting height on the other.

Turning to the correlations given in Table III, we find in the first place, as indeed we could expect, that they are all positive. In the second place the two portions of the table approximately agree. The correlation between height and weight is about .54, a value which corresponds with what has been published. Sitting height apparently does not correlate with weight quite as well as does height. The correlation between height and sitting height is the highest value shown, .70. Shoulders and weight give a value of .45 or .46. However, hips and weight correlate more strongly for the odd group, indeed a little more strongly than between height and weight, while for the even, a little less. This discrepancy between the two portions of Table III, .58 and .51, can not be explained in the light of our grouping method. As mentioned before in reference to Table II, the means for hips were identical, but the other means show differences. Hips correlate more strongly with all the measurements than can be said for shoulders. The correlations of shoulders and hips with weight are stronger than those with height, sitting height or with each other. It is therefore apparent that both these measurements contribute something to the body-build and thus to the total body-weight that is not included in the other measurements. Each correlation value in Table III is several times the size of its probable error. So far as the author knows, these are the first correlations to be published for bony hip and shoulder measurements with weight and the other more usual measures on white male adults.[10a]

Following the suggestions of Miles and Root,[11] Gray and Walker[12] published a short note and gave one diagram for data from different sources which indicate some relationship between body-weight and intercristal diameter; and Gray and Parmenter[13] on one hundred candidates for a varsity football team took measurements and correlated the depth of chest, "nearly a bony measure," with weight. The result found was $.55 \pm .05$. They do not give the height-weight correlation for comparison.

CONCLUSIONS

(1) Two stable bony width measures, the maximal diameter at the iliac crests and shoulder diameter at the acromions, together with height, sitting height and body-weight, were applied to 552 young American men, average age about nineteen years, all entering students at Stanford in October, 1927.

(2) For statistical treatment the men were divided into two approximately even groups. These subgroups are found to compare quite closely. The average height is 176 cm; sitting height 89 cm; shoulder diameter 37 cm; hip diameter 28 cm and average weight 141 pounds. Average height is thus about 4 cm greater than ordinarily reported for white American troops.

(3) The coefficients of variability for the different measures are compared. Shoulders and hips give variability values fully 50 per cent. greater than height and sitting height (5.6 compared to 3.6), while weight shows 11.5 per cent. Weight being a cubic measure shows approximately three times the variability found for height.

[9] Miner, J. R., "The Variability of Skull Capacity," *Amer. Jour. Phys. Anthro.*, 1924, 7, 425–426.

[10] Miles, W. R., and Root, H. F., "Weight and Physical Measurements after Thyroidectomy," *Arch. Inter. Med.*, 1927, 39, 605–617.

[10a] Since this was written some data have appeared: Gray, H., "Weight, Body Diameters and Age; Correlation Coefficients," *Proc. Soc. Exp. Biol. and Med.*, 1928, *25*, 384–385.

[11] *Op. cit.*

[12] Gray, H., and Walker, A. M., "Applied Anthropometry," *Jour. Amer. Med. Assoc.*, 1924, 82, 628.

[13] Gray, H., and Parmenter, D. C., "Chest Depth as an Index of Body-weight," *Jour. Amer. Med. Assoc.*, 1923, 81, 2183.

(4) The correlation between height and weight is about .54 ± .03. For one group, hips and weight correlated .58, for the other group .51. From these observations it appears probable that the bony hip diameter for young men bears as important a relationship to body-weight as does stature.

(5) The correlation between shoulders and weight is about .45 ± .03. Shoulders and hips each correlate with weight more strongly than they do with each other or with height or sitting height. Therefore, they may be assumed to contribute a factor to total body-weight that is not wholly included in the height measurements.

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A PRELIMINARY REPORT ON STUDIES OF FIREBLIGHT OF APPLE[1]

FOLLOWING the classical studies of Burrill[2] and Arthur[2] in establishing the bacterial cause of fireblight of pomaceous fruits and of Waite[2] in discovering the relation of pollinating insects to its dissemination and in developing a method for combating it by excision of affected parts, many valuable contributions[3] have been made to the knowledge of this destructive disease. Nevertheless epidemic outbreaks of fireblight continue to take their toll and commercial pear culture has been abandoned in many sections because of the ravages of blight. In view of the lack of success which has attended numerous attempts of apple growers of Wisconsin to control fireblight by the excision method, it seemed desirable to investigate certain aspects of the epidemiology and control of the disease under local conditions. This work was begun by Brooks,[4] who contributed substantially to the knowledge of the overwintering of the blight organism and the seasonal development of the disease. For three years the investigation has been continued by the present writer[5] through field and laboratory studies.

A clear understanding of the modes of dissemination of the natural inoculum and of access of the organism to the host tissues seemed to be of primary importance to the adequate understanding of the epidemiology of the disease and further development of control measures. Special attention has, therefore, been directed to these aspects of the problem. For many years the prevailing conception has been that the primary inoculum is carried by insects from the cankers where the organism overwinters to susceptible parts of the current year's growth, notably the blossoms, where it induces blighting, presumably penetrating to the interior tissues through the nectaries. Once established in the blossoms, the bacteria have been supposed to be carried to other blossoms chiefly by the agency of pollinating insects, while their direct entrance from external sources to twigs and other susceptible parts has been considered to occur chiefly through wounds. An important modification of these earlier conceptions was necessitated by the valuable contributions of Gossard and Walton,[6] who showed that rain is a very important agent in the dissemination of the inoculum for fireblight. They concluded that from 50 to 90 per cent. of the blossom blight observed in their work was caused by rain-borne inoculum. They state, however (p. 107), that "raindrip does not become an agent of dissemination until primary centers of infection have been established, in nearly all cases by insects." In somewhat similar experiments which appear to have been conducted independently and near the same time, Stevens, Ruth and Spooner[7] showed that blossom clusters and young twigs which were carefully protected from visitation by insects were blighted approximately as much as similar unprotected parts. Access of air and of meteoric water was not precluded. The writers conclude that the disease must have been transmitted by some agency other than insects and state that "the only tenable hypothesis is that wind was the chief agent of transmission."

The exact mode of dissemination of the inoculum which first establishes the fireblight organism in the current year's growth is obviously of great potential importance in relation to control measures. The conception that insects are the agents of this dissemination seems firmly established, yet the writer has been unable to find in the literature of fireblight sufficient evidence to justify such a conclusion. The conditions encountered at Gays Mills, Wisconsin, in the seasons of 1926 to 1928, inclusive, have offered a very favorable opportunity to follow the details of dissemination of the primary inoculum under natural conditions. In each of these three years the earliest infections of both blossom clusters and young shoots have been ob-

[1] Published with the approval of the director of the Wisconsin Agricultural Experiment Station.

[2] Cited (pp. 368–369) in: V. B. Stewart, "The Fireblight Disease in Nursery Stock," Cornell University Agr. Exp. Sta. Bul. 329: 313–372, 1913.

[3] A fuller discussion of literature will be given in a later paper.

[4] A. N. Brooks, "Studies of the Epidemiology and Control of Fireblight of Apple," *Phytopath.* 16: 665–695, 1926.

[5] The writer is indebted to Dr. G. W. Keitt, under whose direction these investigations were conducted, for first suggesting the importance of the problem and for helpful criticisms and suggestions during the progress of the work.

[6] H. A. Gossard and R. C. Walton, "Dissemination of Fireblight," Ohio Agr. Exp. Sta. Bul. 357: 83–126, 1922.

[7] F. L. Stevens, *et al.*, "Pear Blight Wind Borne," SCIENCE, N. S., 48: 449–450, 1918.

served to occur, almost without exception, below hold-over cankers or twigs in positions favorable for water-borne dissemination of bacteria from these sources. In 1926 and 1927 young blossom clusters were found blighted well in advance of the opening of the blossoms and at a time when there was a striking dearth of insects which might have carried the bacteria. These field observations suggested the working hypotheses: (1) that meteoric water plays an important part in disseminating the primary inoculum of fireblight and (2) that the bacteria are able to infect unopened blossoms and young shoots without the intervention of insects. It was sought to test these hypotheses by observations and experiments. A very brief summary of the evidence relating to the first follows:

1. In observations in the orchards at Gays Mills for three consecutive seasons the earliest observed cases of blossom and twig infection have occurred, almost without exception, in situations favorable for water-borne dissemination of the inoculum from active hold-over cankers or twigs.

2. During the periods of early primary infection there was a dearth of insects which might transmit the bacteria.

3. In extensive observations of active hold-over cankers during three seasons no insect was observed to visit the bacterial exudate.

4. The time when primary infection occurred was correlated with rain periods, the symptoms becoming evident after a normal incubation period following rain, as was revealed by inoculation experiments conducted in the orchards.

Attention was next directed to the manner in which the bacteria gain access to the tissues of the host. It has long been accepted that this is accomplished in two ways: (1) through the open blossoms, presumably through the nectaries, and (2) through wounds of many kinds. Neither of these modes of entry, however, would seem to accord well with the facts observed in the field. Consequently a study was made of the possibility of infection of young shoots and unopened apple blossoms by *B. amylovorus* without the intervention of wounds. On the basis of observations, Heald[8] expressed the opinion that the bacteria may gain entrance to leaves through water-pores and stomata, but stated that it remained for further investigation definitely to substantiate this view. In his manual the same author[9] states (p. 315): "The writer studied fireblight in Washington in the summer of 1915 and found leaf invasions common in pear, apple and quince, and later produced artificial infections through the leaf margins by the use of pure broth or bouillon cultures. Leaf infections occurred through marginal breaks, insect punctures or through perfectly sound leaves." Brooks[10] reports negative results from numerous inoculation experiments with unwounded apple leaves in the field and in the greenhouse. Most of this work was done, however, after the twigs had made considerable growth. Working with potted plants in the greenhouse the present writer has induced at will abundant infection of young shoots and unopened blossom buds of apple and pear by spraying them with a suspension of the fireblight bacteria (from pure cultures on potato dextrose agar slants) in sterile distilled water and placing them for varying periods in a moist chamber at suitable temperatures. These experiments have been repeated many times with consistent results. In numerous series the plants were treated with "Derrisol"[11] before the buds opened and were kept throughout the course of the experiments in compartments designed to preclude injury from insects or other agencies. Histological studies are being made of tissues which were killed and fixed at various intervals after inoculation. While this work is unfinished, cases of stomatal penetration have been found in tissues taken from (a) an inoculated young leaf of apple and (b) from the inside of the receptacle cups of apple and pear flowers that were open when inoculated. The results of inoculation appear to be strongly influenced by the condition of the tissues at the time of the experiment.

Inoculation experiments in the field yielded results which accord well with those obtained in the greenhouses. Young shoots, unopened blossoms and open blossoms were infected when sprayed with a bacterial suspension of *B. amylovorus* and enclosed in moist chambers. The percentage of positive results, however, was much more variable than in the case of the greenhouse tests, where conditions could be controlled more satisfactorily. In certain of the field trials, precautions were taken against wounding by insects or other agencies, and infection resulted from inoculations of young shoots and unopened flowers.

The data now available appear to justify the conclusions: (1) that, under Wisconsin conditions, meteoric water is an important agent for the dissemination of the primary as well as the secondary inoculum for fireblight of apple, (2) that *B. amylovorus* may infect young leaves and unopened blossoms of apple and pear without the intervention of wounds and (3) that,

[8] F. D. Heald, "Preliminary Note on Leaf Invasion by *Bacillus amylovorus*," Wash. Agr. Exp. Sta. Bul. 125: 1-7, 1915.

[9] F. D. Heald, "Manual of Plant Diseases," 890, 1926.

[10] A. N. Brooks, *loc. cit.*

[11] "Derrisol" is a proprietary contact insecticide. It was applied as a spray, the chief purpose being to kill any aphids which might be present.

under suitable conditions, *B. amylovorus* may cause infection following penetration through stomata. In the light of these results it appears that the rôle of insects in the dissemination of fireblight is less important than was earlier believed and needs to be re-evaluated. The possibilities of using the excision method as one part of a successful control program seem to be considerably enhanced. Strong potentialities appear to lie in the use of chemical treatments designed to inactivate such primary inoculum as escapes the excision process. Experiments on this phase of the problem are in progress but the results are, as yet, inconclusive. The investigation is being continued, and the results will be reported in more detail in later papers.

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FURTHER OBSERVATIONS ON SCHISTOSOME DERMATITIS IN THE UNITED STATES (MICHIGAN)[1]

IN a recent publication[2] I discussed the production of a dermatitis by the penetration into the human skin of a non-human species of schistosome cercaria, *Cercaria elvae*. This experimental schistosome dermatitis was identified as the same condition as that occasionally contracted by wading at certain places near the University of Michigan Biological Station on Douglas Lake, Michigan. It was suggested that this type of dermatitis might be widespread and might be produced by other schistosome cercariae besides the one implicated experimentally. Since the publication of this paper some new evidence has been obtained on both these points.

A popular discussion of this subject based on the original paper was syndicated by a writer of health articles and published in May in a number of newspapers throughout the United States. Following this, a number of letters were received asking questions or volunteering information on various sorts of skin conditions. Ten of these letters gave accounts of a definite dermatitis contracted by the contact of some part of the body with water, in most cases in wading or swimming. All these reports were alike in recounting the extreme itching and the spontaneous disappearance of the dermatitis after a few days or at most several weeks, depending on its severity. In certain of the cases the letters report that physicians consulted were unable to give a diagnosis. Rather detailed descriptions were given in some cases of the development of papules. The reports of the "water itch" which these ten individuals identified as the same as the schistosome dermatitis were from widely separated places, including in the United States the states of Iowa, Washington, Illinois, Florida, Minnesota, Wisconsin and Michigan, as well as Haiti and France. Whether these records really represent accounts of schistosome dermatitis is difficult to determine. It is, however, very suggestive, when an eruption of a papular nature, which produces extreme itching and disappears in a few days or a week is contracted from wading or bathing in shallow water where the bottom is muddy. Some of these records were of such interest that they are being followed up further so that further details will not be given in this preliminary note. I would be glad to hear of further cases of dermatitis contracted from wading or bathing under conditions which might make possible infection from cercariae escaping from snails.

It has also been possible this summer to produce the dermatitis experimentally by placing on the human skin three further species of schistosome cercariae. One of these was identified as *Cercaria douthitti*, which was originally reported from specimens of *Lymnaea reflexa* from a small pond in the suburbs of Chicago, Illinois.[3] This cercaria is present although not common in *Lymnaea stagnalis appressa* and *L. stagnalis perampla* from the shores of Douglas Lake. A few specimens of *C. douthitti* placed on the skin of two volunteers produced the same kind of lesions as those produced by the penetration of *C. elvae*. Two other species of schistosome cercariae which resemble *C. elvae*, but differ in certain definite and easily distinguished characters were found during this summer. Since these cercariae are being studied by one of the research students at the Biological Station any description of them will be reserved until later. The important point here is that both of these cercariae penetrated into the human skin and produced schistosome dermatitis. This means that four of the five species of schistosome cercariae which have been found in the region of Douglas Lake in the last two summers have been shown to penetrate into the human skin and to produce a definite schistosome dermatitis. This gives support to the view expressed earlier that this condition is probably rather widespread and may be produced by a variety of cercariae of this group.

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[1] This paper is a joint contribution from the University of Michigan Biological Station and the Department of Helminthology of the Johns Hopkins University School of Hygiene and Public Health.

[2] Cort, W. W., "Schistosome dermatitis in the United States (Michigan)." *J. A. M. A.*, Vol. 90, pp. 1027–1029 (March, 1928).

[3] Cort, W. W., "Larval trematodes from North American fresh-water snails." Preliminary report. *Jour. Parasit.*, 1: 65–84 (1914).